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MONTHLY

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AUTOMOBILES • HOME & SHOP • MECHANICS

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JUNE

JOHN T. McCOY, JR.

Training America's Air Dogfighters

PAGE 106

YOU TEST A COIN BY ITS RING . . .

YOU JUDGE A FLY ROD BY ITS ACTION . . .

ETHYL

ETHYL GASOLINE CORPORATION

AND WHEN YOU STOP TO BUY GASOLINE, THIS EMBLEM TELLS YOU WHICH PUMP CONTAINS THE BEST

THE ETHYL EMBLEM on a gasoline pump stands for *extra* quality in anti-knock (octane) and all-round value. Samples are double-checked by your oil company and the Ethyl laboratories.

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You steer . . . *Fluid Drive* does the work!

YOU'RE not at work, when you're *Fluid Driving.* You're steering today's most ingenious and obedient car . . . and you'll get a big kick out of it!

Fluid Drive is the first new motor car feature in years that does something really big for the driver!

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You put on the brakes for a traffic light . . . but you stay in high gear position! You glide away again when the light changes . . . but all you've done is to step on the gas! In all normal driving, you drive this way . . . and you realize what a relief *Fluid Driving* brings.

Try *Fluid Drive* with Vacamatic transmission at your Chrysler dealer's. It's standard equipment on most Chrysler models this year and only a few dollars extra on the lowest-price Chryslers.

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Buy Chrysler!

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 138 NO. 6

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

CONTENTS for JUNE, 1941

News

Automobiles

Home and Workshop

Departments

HICKMAN POWELL, who tells the story of Dr. Sanford A. Moss's red-hot tornado on page 66, is a veteran newspaperman now specializing in personality sketches for many magazines. As a reporter for the New York Evening World and later for the Herald Tribune, he covered some of the most sensational stories of recent years. His latest book is "What the Citizen Should Know About the Coast Guard."

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 26, 1915, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

Single copy, 15 cents; Canada, 20 cents. Yearly subscriptions to United States and its possessions, $1.50; Canada, $2.00; foreign countries, excepting Canada, $2.50. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

WAKE UP AND SUCCEED!

YOU'LL wake up some day and find you're TOO LATE to succeed! Too old—too tired—*too deep in a rut!*

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Present Position.....

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Automobiles

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Craftwork

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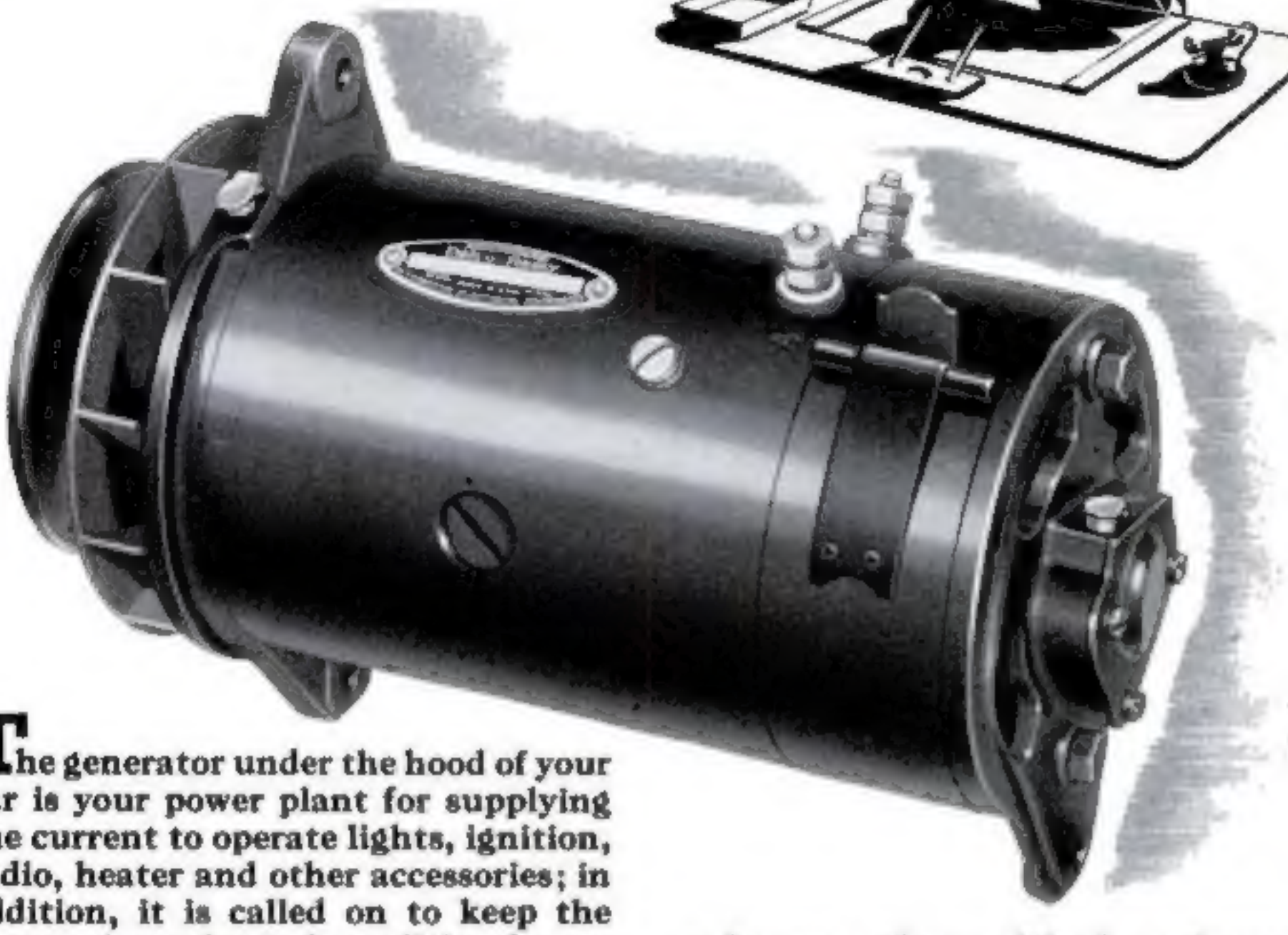
YOU are president of a power plant



The generator under the hood of your car is your power plant for supplying the current to operate lights, ignition, radio, heater and other accessories; in addition, it is called on to keep the battery in a charged condition by replacing the energy consumed by the cranking motor in starting.

As president of this power plant, you have certain responsibilities. *First*, know the make and capacity of the generator in your car. *Second*, see that the generator is kept in good condition to supply the current for your requirements; a good battery that requires frequent charging is a sure sign that the generator or regulator needs attention. *Third*—and very important—make sure that original equipment parts are used in servicing your generator.

Delco-Remy generators, incorporating in their design the improvements and refinements of Delco-Remy's long manufacturing experience, are original equipment in millions of cars and trucks—nearly half of all cars and trucks sold. Delco-Remy original equipment service parts and replacement units are available at good service dealers everywhere.

Delco-Remy

World's Largest Manufacturer of Automotive Electrical Equipment

Contents [CONTINUED]

Home Building

Miscellaneous

New Shop Ideas

Outdoors

Photography

(Continued on page 8)

HIS MOTHER-IN-LAW WAS PLENTY SORE

—but he's out of the dog house now!

"WHERE YA GOIN' with my pipe?" wailed Henry. "To the incinerator — where *all* smelly things belong," snapped his mother-in-law. "That tobacco is impossible."

ONE WEEK LATER. Now Henry's in clover. Even his mother-in-law treats him right since he switched to Sir Walter Raleigh. Try this mild burley blend. Fifty pipe loads, 15¢.

Tune in... **UNCLE WALTER'S DOG HOUSE**

EVERY WEEK ★ NBC ★ PRIZES FOR YOUR "DOG HOUSE" EXPERIENCE

Contents [CONTINUED]

Radio

Shop Data File

The Handy Man

Woodworking

Your future may be inside these pages!

THAT suggestion, in past years, has prompted thousands of men and women, uncertain how to plan their futures and safeguard their business success, to investigate the career possibilities in Accounting. Having investigated, they went further: took LaSalle training in their spare time; qualified for well-paid positions; and in so doing solved their progress problems successfully.

Among those thousands were more than 1,900 who are now Certified Public Accountants—nearly 10 per cent of all the C.P.A.'s in the country.

What ARE My Opportunities?

Frankly, they are important ones—and numerous. Beginning opportunities as bookkeeper, cost clerk, billing clerk, time clerk. Advanced opportunities to serve in big and small business firms; advising on finance, analyzing costs, helping to shape policies. Opportunities to qualify in the Governmental accounting jobs that are opening up more and more. Opportunities in private practice, as a cost consultant or C.P.A.

One has only to study the statistical side of the news about business expansions, new lines of manufacture and marketing, to see that wherever business is busy accountants are busy. For remember: this is the profession back of the financial success and progress of *all other enterprises*. And accountancy incomes of $2,000 to $10,000, or more, yearly, certainly aren't earnings to be dismissed lightly!

The Best Answer of All

These are only a few facts in passing. Facts, however, that certainly invite your very thorough further investigation as to what LaSalle Training for this profession of many opportunities has in store for *you*.

Complete information—a survey covering this subject from different angles—is what you should have now, before making any final decision. You'll find it in this 48-page book. And it is aptly titled "The Profession That Pays" . . . for, as the official *Journal of Accountancy* has pointed out: "If there be a profession in which the average compensation is higher, it is not known to us." So, if you really are in earnest—and willing to study seriously—fill in and mail the coupon for your copy today. *Your* future may lie inside its pages!

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Coming Next Month—

BLIMPS in the modern, streamline U. S. Navy? Yes, indeed. Lighter-than-air craft have a definite place in the plans for our naval defense. What their work would be in time of war, how the Navy is building them and training the men to man them, is told in an article by John Watson.

DAYLIGHT is no longer the capricious, unmanageable thing it used to be. Architects and builders are now able to direct and control it in homes, offices, and factories by the use of new materials and products developed by the glass industry. An article on "Light Conditioning" describes these new aids to comfort and efficiency.

FLYING POSTMEN, riding their routes at more than 100 miles an hour without stop, now pick up and deliver mail in communities off the regular air-mail routes. Read "R.F.D. Gets Wings," by Charles Morrow Wilson, for the story of this interesting new development in commercial aviation.

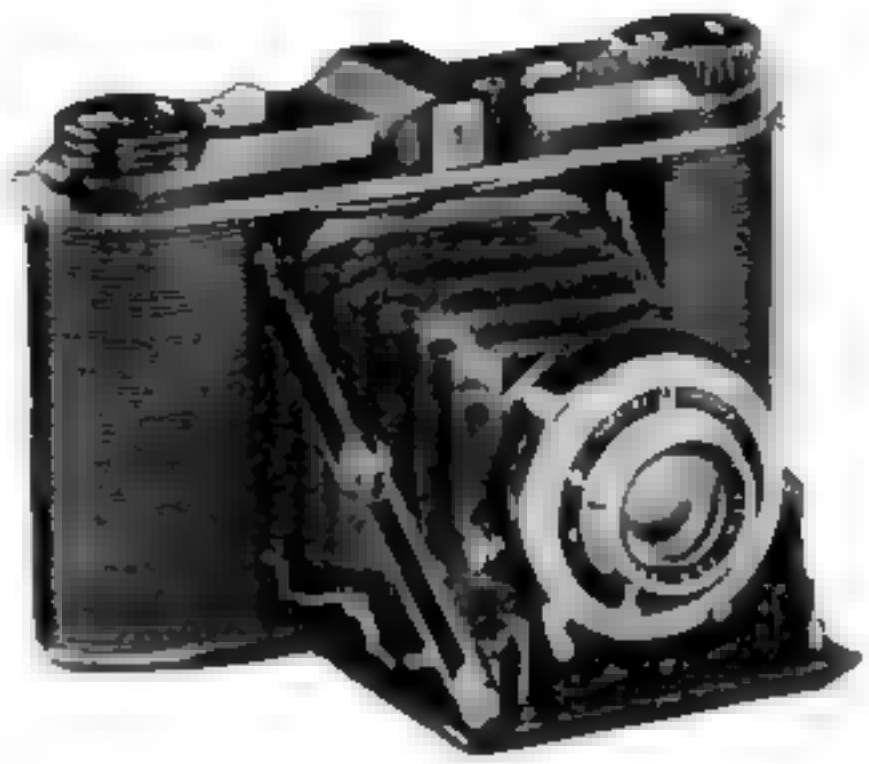
OUTDOOR FURNITURE will make your garden more livable. An article shows how to build your own garden suites, servers, lawn chairs and settees—some of them with wheels so that they can easily be moved to choice spots. Construction is simple, but your friends will exclaim over these serviceable, attractive pieces all the same.

INSIDE A MILITARY TANK is about the noisiest place you could find. But did you ever stop to wonder why it isn't just about as noisy inside your family car? After all, both pack powerful engines and both are constructed mostly of metal. What's the answer? Why does your new car run so soundlessly? To get the low-down, Schuyler Van Duyne takes you right into the car makers' "quiet rooms" and sound laboratories in "Detroit Sound Detectives Give You Quieter Cars."

NO ELECTRIC SERVICE available at your summer home or farm? You can make a lighting plant of your own from two junked automobile generators and a gasoline engine. Everything you'll want to know is told and well illustrated in a comprehensive article. Best of all, the unit delivers 110-volt alternating current, so that you will be able to plug in your favorite radio just as at home.

SENSATIONAL CAMERA VALUE!

Agfa Speedex: $29.00



• This beautifully compact Agfa Speedex takes *twelve* 2¼ x 2¼" pictures! Here are its All-American features!

1. Brilliant, eye-level view finder.
2. Highly-corrected f4.5 anastigmat lens.
3. Precision shutter speeds of ½ to 1/250th of a second, Time and Bulb.
4. Focuses 3½ ft. to infinity. Focusing ring in lens mount.
5. Built-in shutter release on camera top!

Your dealer will let you see and handle this fine camera. Ask him!

SPEEDEX JUNIOR: Same features as above, but with less elaborate lens and shutter for fixed-focus operation. Only $11.00! *Agfa Ansco, Binghamton, New York.*

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only EVINRUDE GIVES THIS SMOOTHER 4-cylinder PERFORMANCE

S-M-O-O-T-H! . . . here's silky smoothness . . . surging responsiveness . . . thrilling performance that packs more pleasure into every mile! And now you can choose a *four-cylinder* Evinrude right in the same price range with "twins" of comparable power. Evinrude offers 4 great "fours" — see them at your dealer, or write for new catalog!

NEW FULL REVERSE! Now yours in two famed light motors, Evinrude's advanced development of *Full Reverse!* Steer in any direction . . . reverse the course . . . back away from crowded docks . . . the last word in complete *maneuverability* is built into these two models.

CATALOG FREE! Handsomely illustrated, full-color catalog of 9 Evinrude models—also catalog of 6 Elto models priced as low as $26.50—handy Boat-and-Motor Selector and Boat Guide of Leading Builders—Free. Address: EVINRUDE MOTORS, 4770 N. 27th St., Milwaukee, Wis.

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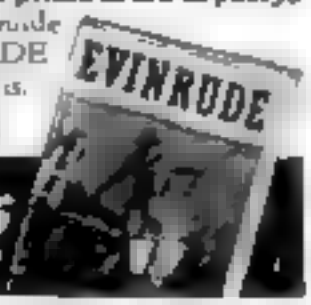

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TIMES ON REQUEST: Marlin signet ring, simulated gold. Include 10c for postage, packing.

Readers Say:

WHEN R. E. B., of Canfield, Ohio, asked our readers to suggest uses for empty cheese boxes, he started something. Of the scores of letters received, many illustrated with drawings or photographs, it is possible to print only a few representative examples. A few readers also told of uses for the large, round "wheel" cheese boxes. To all these readers, thanks.

C.M.W., Cincinnati, Ohio, uses cheese boxes for combination drawers and boxes for nails

For "Kraftsmen," the Cheese Is Only a By-Product

I HAVE been wondering why no one mentioned making shop cabinets out of cheese boxes, and along comes the query from R.E.B. I have been making these cabinets for ten years and have the shop about full. Size of cabinet depends on the number of cheese boxes you intend to use as drawers. Fronts of the boxes are sanded and stained, and I put on brass card holders with the pull lip attached. Such cabinets are ideal for holding screws, bolts, nuts, and other small parts.—S.J.G., Wichita, Kans.

RECENTLY I saw a bed lamp made from a two-pound cheese box. It had a piece of No. 9 wire attached to it, for hanging on the head of the bed. A regular light socket was inserted, and a 25-watt bulb.—J.H.S., Harrisonburg, Va.

MY ONLY trouble with cheese boxes is in finding enough. I have used them for seed boxes, boring holes in the bottoms for drainage and putting in a layer of pebbles, then filling with loam and sprinkling the seed on top.—H.T., Warren Point, N. J.

You can make a feed trough for chickens out of a five-pound cheese box by sawing it lengthwise to leave the bottom and one side joined together, and nailing a small board at each end to hold the trough upright.—R.M., Notre Dame des Anges, Quebec.

A CHEESE BOX makes a good rack to hold chemicals, when plywood legs are glued on at each end. After staining, it should receive a coating of water glass to protect it from chemical stains.—D.B., Lynchburg, Va.

MY CHEESE BOXES go to make stormproof, cat and dogproof feeding stations for our little friends, the birds. All it takes, besides a cheese box, is some tin for roof and ends, and some wire.—G.H.W., Roanoke, Va.

WE MAKE very attractive flower boxes out of cheese boxes. First we sand off the markings and give them two or three coats of paint inside and out. Then we decorate the fronts with decalcomania transfers.—G.E.S., Jackson, Mich.

Ten Cheese Boxes Stack Up as an Attractive Cabinet

IN ANSWER to your request for cheese-box projects, I inclose a photograph of a portable cabinet made from ten of these boxes. Five boxes are nailed together to form each side of the case, using 1" finishing nails. Slats are nailed to the ends of the boxes, and the two sides are joined with hinges and a latch. Handles are bolted to the top. One-inch strips of wood can be nailed to the front edges of the boxes so that small articles will not fall out. Two coats of paint, inside and out, complete the job and make an attractive cabinet.—F.S., New York City.

Readers Say:

A Sidewalk Superintendent Wants to See It in Print

WHILE watching workmen excavate for a new building, I noticed how many other people were standing around watching also. I always got a kick out of such things, so I thought it might be a good idea for you to show a bridge or a dam in process of construction. There must be many more readers who feel as I do.—R. W., New York City

Keep Flame Away from Your Automobile Battery

COATING car-battery terminals with candle wax, as suggested in your March issue, can be dangerous if it is done by holding the lighted candle above the battery. Fumes coming from the battery can ignite, causing an explosion. I know this is true because I have seen it happen. Better melt the wax somewhere else and pour it on the terminals.—C. A., New York City

We Thought All Boats Had a Fluid Drive

BEING specially interested in the principle of the "fluid drive," I have been wondering whether it could be used on boats. It is the coming thing in automobiles, and I believe it might be equally good on light boats.—R. M., Hackensack, N. J.

One of the earliest applications of the hydraulic torque converter was made on internal-combustion-powered towboats and other harbor craft.—Ed.

The Math Sharks Take a Ride on J. R. G.'s Adding Machine

J. R. G., who engaged in the youthful pastime of playing with an adding machine, was quite correct in his supposition that adding 1 to 2 to 3, and so on up to 1,000, would produce an answer of 500,500. In order to verify this answer, I would advise him to consult his algebra book rather than his adding machine. The formula for the sum of the terms in an arithmetic series is: sum equals number of terms divided by two, times the sum of the first and last terms.—W. D. P., Santa Barbara, Calif.

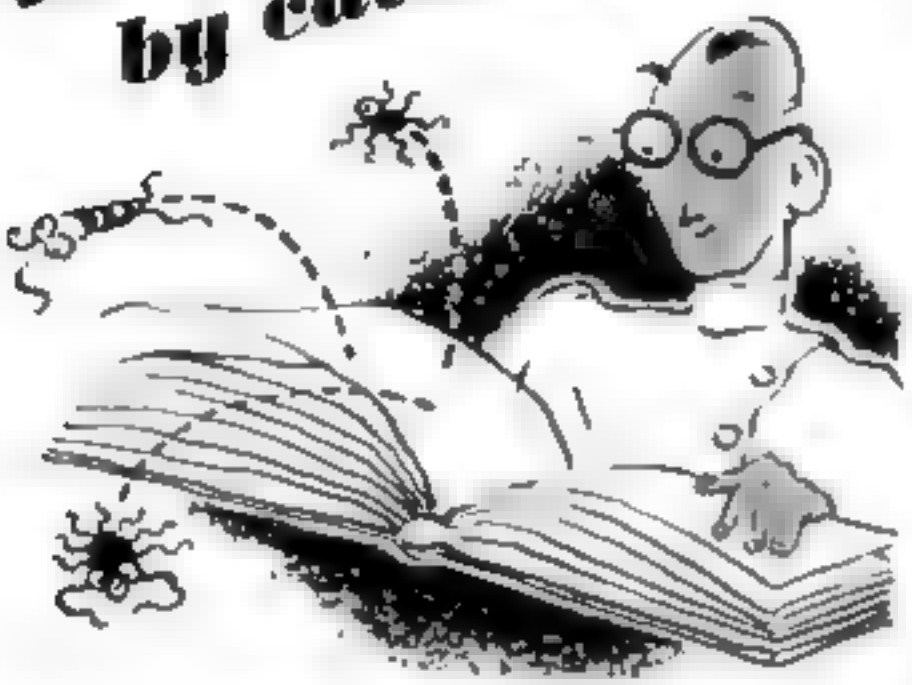
—

J. R. G.'s surmise, that if the sum of the numbers from 1 to 10 equals 55 and the sum of the numbers from 1 to 100 equals 5,050, the sum of the numbers from 1 to 1,000 should equal 500,500, is correct. Moreover, the sum of 11 to 20 equals 155, the sum of 21 to 30 equals 255, the sum of 31 to 40 equals 355, etc., *ad infinitum*. The same characteristic may be observed in relation to the sums of the several hundreds, and of the thousands, namely, the sum of 101 to 200 equals 15,050, the sum of 201 to 300 equals 25,050, etc.; the sum of 1,001 to 2,000 equals 1,500,500, the sum of 2,001 to 3,000 equals 2,500,500, etc. The same relation crops up in number systems containing more or less than ten numbers. For instance, the sum of numbers 1 to 12 is 78, and 78 in a number system composed of 12 numbers is equal to 66. Also the sum of numbers 1 and 2 is 3; in a number system of two numbers, 3 would be expressed as 11. As far as I have been able to ascertain, this quality of numbers has no practical value.—E. V. C., Cicero, Ill.

Anyhow, It Would Be a Rest from Stukas and Such

IN THIS day of warfare and strife, I think it would be a good idea for you to publish an article telling how the people of ancient and medieval times fought their wars. But more than that, I would like for you to publish plans for making models of some of their weapons, such as catapults, crossbows, and wall-scaling towers. Making these is my hobby, and I am out of ideas.—R. E. M., Clayton, Ohio.

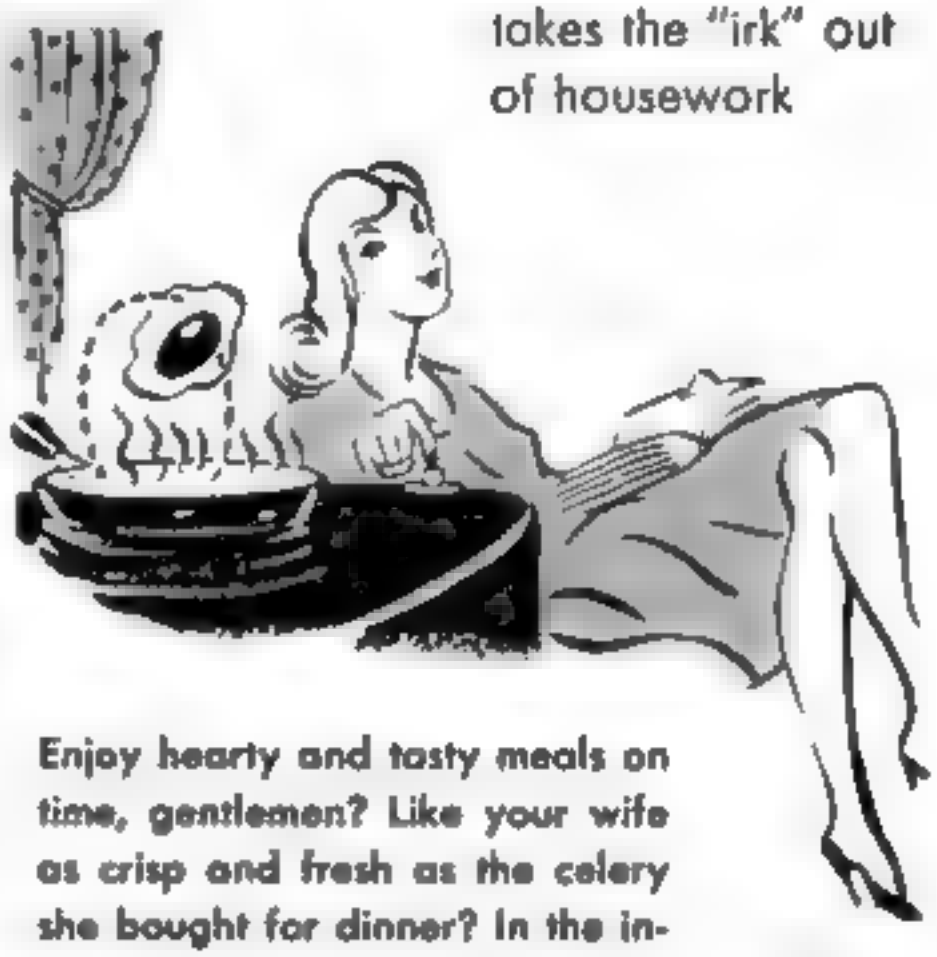
they sell microbes by catalogue



In North Carolina there's one of the world's strangest enterprises . . . a microbe farm! A laboratory devoted to propagating those elemental forms of life like amoebas and hydras and their many cousins. Dr. T. E. Powell sells them by *catalogue* to universities, medical schools, and other scientific centers studying human life. *Popular Science on-the-screen* let's you meet these fascinating inhabitants of a dramatic world we never see with the naked eye. Don't miss it at your local theatre.

streamlined kitchen

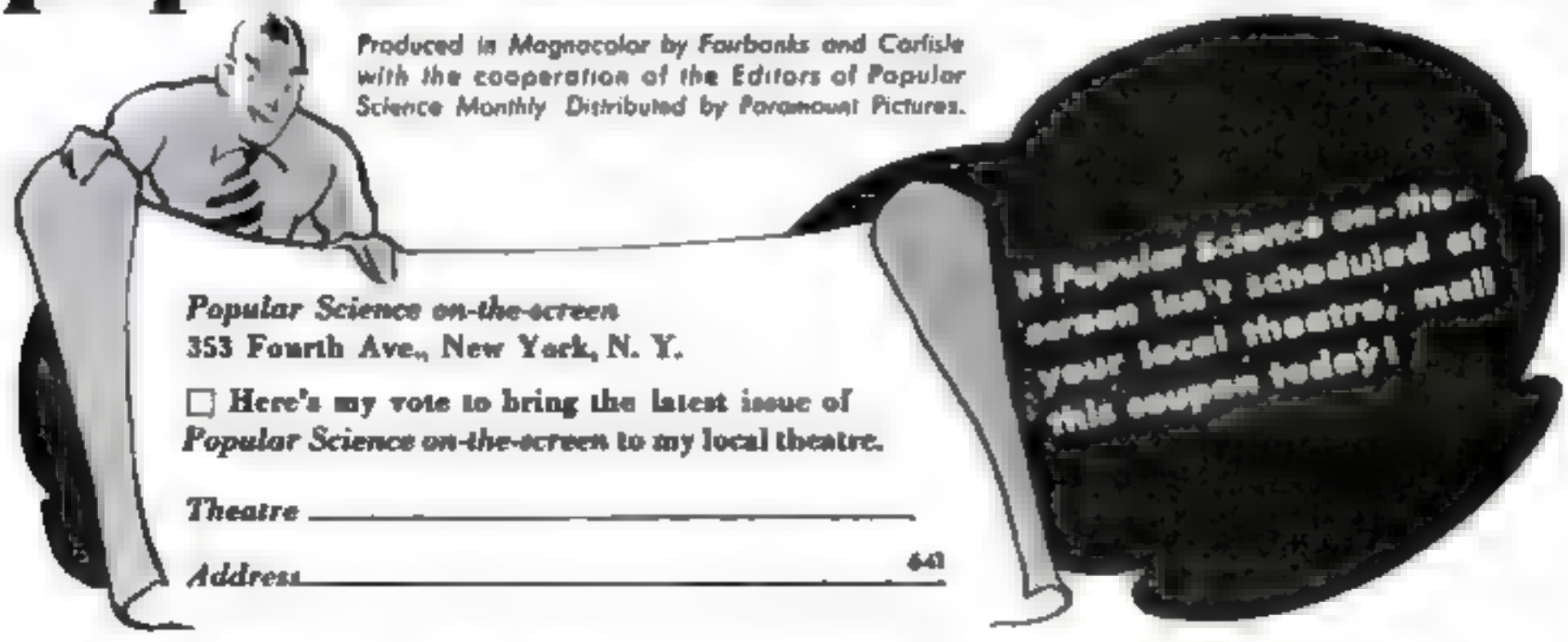
takes the "irk" out of housework



Enjoy hearty and tasty meals on time, gentlemen? Like your wife as crisp and fresh as the celery she bought for dinner? In the interests of both considerate and selfish husbands, *Popular Science on-the-screen* reports on the latest kitchen kwickies . . . modern scientific conveniences that make the kitchen a playground (we hope)! If you are out to make a hit with the little lady, take her to see this feature of *Popular Science on-the-screen* . . . and get ready to improve that kitchen!

popular science *on-the-screen*

Produced in Magnacolor by Fairbanks and Carlisle with the cooperation of the Editors of Popular Science Monthly. Distributed by Paramount Pictures.



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Address _____ 641

Readers Say:

Right Now We're More Interested in a Mothproof Bathing Suit

WHY DOESN'T some one invent a floating hockey puck? I noticed last winter how many times a puck is hit by an amateur player and lands in the nearest hole in the ice. Trying to fish it out is of no avail, as it immediately sinks to the bottom like a leaden weight, much to the distress of the players. A floating puck would surely be an asset to hockey players.—D. S., Medford, Mass.

Thread Dial Indicator Made Without That Worm Gear

IN YOUR November 1940 issue there was an article by C. W. Woodson on a thread dial indicator. It's fine; I built it. But here's an angle to that project which perhaps many a chap overlooks: I have cut a number of relatively large worm gears for astronomical instruments, using the method the author describes. That's very good dope, and it was an excellent idea to publish it. However, it scared some chaps away; they thought it too difficult. I spoke to two men who had given up the idea and told them to use a 32-tooth steel spur gear, which is obtainable at low cost, instead of the worm gear. This will work just as well and it reduces the cost of building the dial indicator to only a fraction of what it would be with the worm gear.—H. B. B., Pittsburgh, Pa.

He Wants No Nail Polish on HIS Scale Weights

WITH all due respect for K. L. R., I disagree with him on his idea of coating photographic scale weights with nail polish, as suggested in your March issue. The added weight of the coat of nail polish would render the weights inaccurate, especially gram weights.—H. A. S., Jr., Los Angeles, Calif.

Readers Say:

One More Tabby Gives All for Dear Old Science

BEING interested in the experiments of O. C. T., West Lafayette, Ind., to see how a cat takes up milk with its tongue, I tried it on our old cat. I found that the milk enters the cat's mouth under his tongue. On the down stroke, our cat seemed to kick the milk back into the mouth instead of dipping it up on the upper surface of the tongue. When corn flakes are in the milk, they stick to the upper surface of the tongue.—H. K. C., Flint, Mich.

Another Cellar Machinist Volunteers for Defense

R. S. B., of Gothenburg, Neb., is right about putting homeworkshop fans on defense jobs. I also have been a machinist for 22 years, but at present am on the police force and on duty eight hours a day, with nothing to do after hours except play around with a small lathe, drill press, shaper, and milling machine which I purchased from advertisers in your magazine. I could make a number of small parts for defense items.—J. W. S., Ambler, Pa.

We Wonder Why They Put Casters on Furniture

THE letter from L. G. M., Minneapolis, Minn., whose father could "make the table walk," interested me particularly because my mother has the same power. I'd love to be able to do it myself, but I guess I don't have enough electricity in me, or something.—M. L. H., Upper Darby, Pa.

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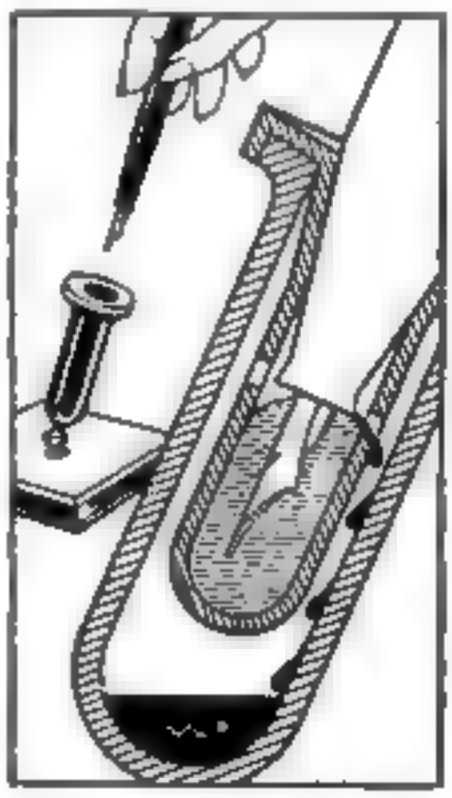
toward an inevitable collision with the cars of the adjoining wheel. To make the sensation even dizzier, the wheels revolve on a slanting instead of a level plane. . . . IT LOOKS SIMPLE—but there's quite a bit of inventive headwork behind a penholder for a desk set, devised by Samuel W. Traylor, Jr., of Allentown, Pa. When the pen is inserted in its socket, a pool of mercury prevents ink on the point from drying and caking. As soon as it is removed, the pen is ready for instant use. Moreover, the pen point is kept bright and clean by its mercury bath, with which ink will not mix. Therefore any writing fluid automatically is wiped from the point, and rises to the top of the mercury, whence it rolls off the convex meniscus of the fluid metal through small holes leading to a reservoir below. (Mercury, because of its high surface tension, will not pass through the holes.) As often as necessary, the reservoir may be cleaned. The receptacle is designed for pens with steel or iridium points, and not for those of gold or gold alloy, with which the mercury would form an amalgam. . . . A "CRASH PROTECTOR" to save occupants from injury, if a plane noses over and lands on its back, is proposed by Alex-

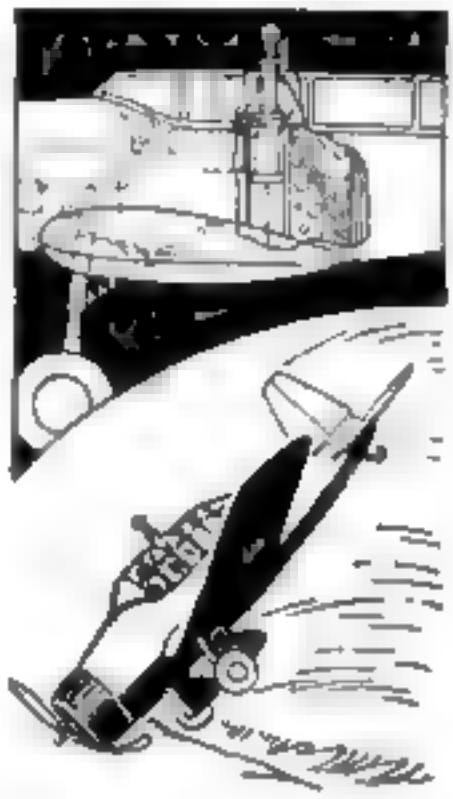


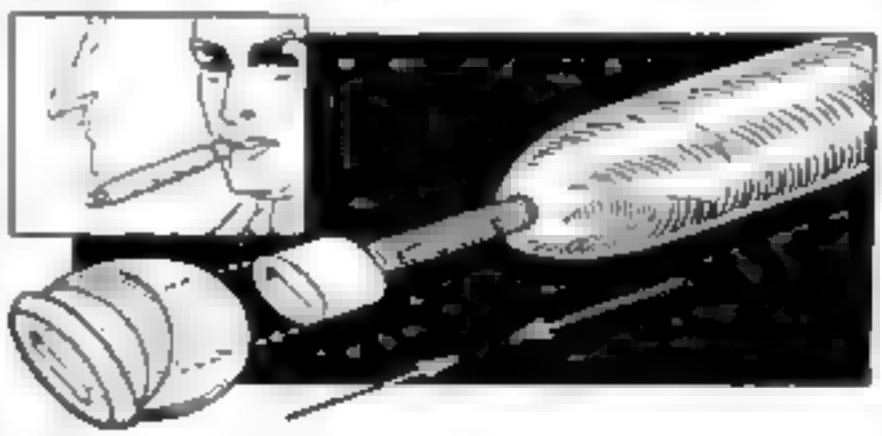
(Continued on page 22)

With the Inventors

(Continued from page 20)

ander P. de Seversky, president of the Seversky Aircraft Corporation. In a design he has just patented, the device consists of a rugged telescoping strut, withdrawn into the fuselage during flight by the same mechanism that retracts the landing gear. When the wheels are lowered for landing, the crash protector simultaneously rises so that it projects well above the cabin or cockpit. Should the plane turn over, an air-inflated rubber hemispheremakes initial contact with the ground. The impact forces a plunger back into its seat against a cushion of air and finally a hydraulic-type shock absorber. If those aboard the plane are securely strapped in, they will not even be jarred by an upside-down landing, the inventor maintains. His safety aid, because of its compact form, offers a minimum of interference with vision. . . . Not too flattering to *Homo sapiens* is the title of patent no. 2,233,397. It reads, "Harness for Dogs and Children." . . . INSERTED LIKE A SCREW in the end of a cigar, a holder invented by Thomas R. Schlitz, of Newark, N. J., provides a secure means of attachment. Oval in cross section, its threaded portion spreads the packed tobacco as the holder or cigar is twirled between the fingers, forming an open chamber within the cigar. The fragrant smoke may then be drawn freely





through a slot in the side of the embedded tube. For cleaning, the holder may readily be taken apart as shown. . . . MANY INVENTORS have proposed amphibian craft, but a

(Continued on page 24)

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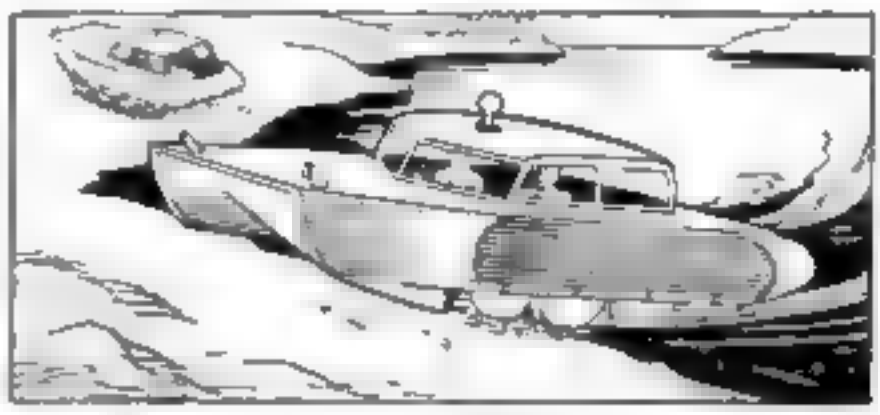
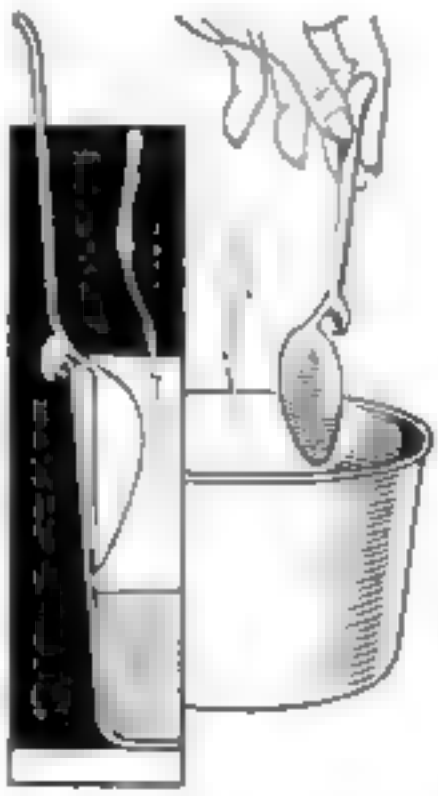
With the Inventors

(Continued from page 22)

land-and-water vehicle patented by George E. Powell, of Glendale, Calif., attracts special interest by its simplicity. Afloat or ashore, the pilot-driver employs the same gearshift and other controls. Endless tractor treads, with shoes of folded, reenforced



rubber or leather, propel the hybrid vehicle. In climbing a beach and traveling on land, the shoes afford resilient traction; in the water, they serve as paddles for the propellerless craft. Treads may be operated independently, for turning, by individual clutches. Either a gasoline or Diesel motor may be used as a power plant. The inventor foresees possible applications as a pleasure craft, a life-saving boat, a freight carrier, and a towboat, as well as an armed amphibian tank for military uses. . . . FOR A PATENT APPLICATION, drawings will usually illustrate an invention sufficiently. *Do not submit a model unless it is called for.* . . . A SPOON THAT STAYS PUT, on the rim of a cook pot or other utensil, is a welcome contribution of Kent Whitman, of Boston, Mass., to the convenience of housewives. Just above the spoon's bowl, a hook-shaped extension projects from the handle to serve as a support. By this simple expedient, which makes you wonder why you didn't think of it yourself, the spoon is prevented from slipping down into the contents of the pot. It also remains cool to the touch, instead of burning the fingers when it is picked up. . . . WATCHING A MOVIE SHOW in a fully lighted room or theater is



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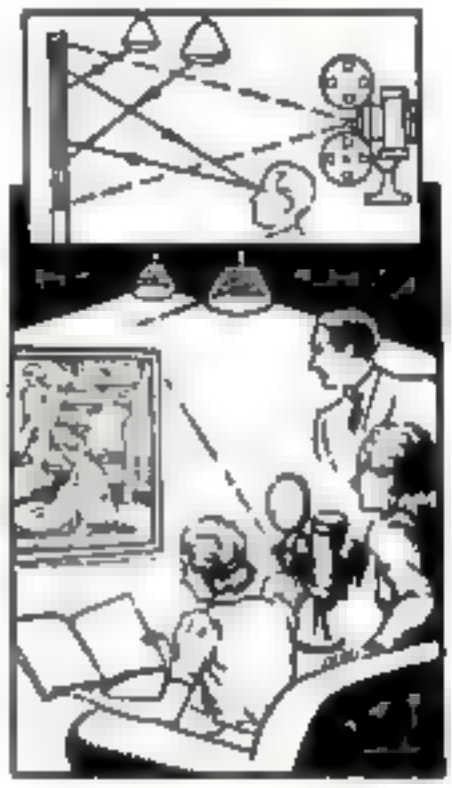
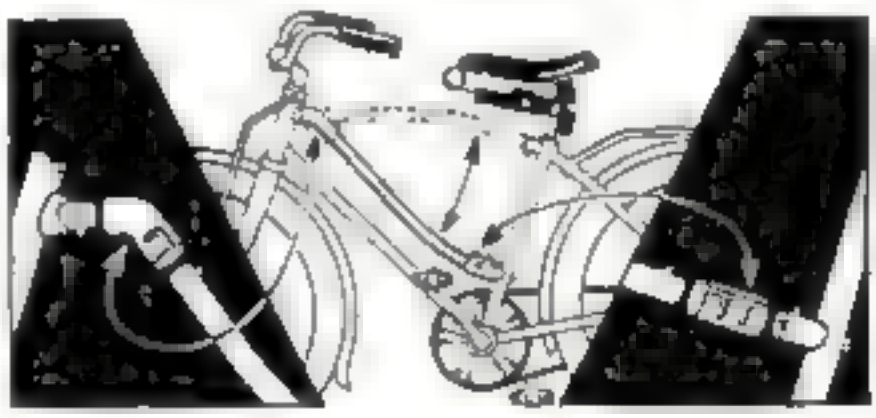
With the Inventors

(Continued from page 24)

made possible by a scheme of recent invention. The secret lies in using room lights of one particular color; and a projection screen that absorbs this color alone, reflecting all other rays. For example, the main illumination may come from sodium-vapor lamps. In this case, the screen is of frosted glass containing such rare metals as neodymium or didymium, which absorb the yellow light of sodium vapor. In consequence, the screen appears black, until motion pictures are thrown upon it by a projector using ordinary white light. The film is then seen as usual. In the same way, it is suggested, television pictures could be observed through a transparent screen of special glass without darkening the room. . . . DISPOSAL of half or quarter shares to a patent is not unusual, but a New Orleans, La., inventor of a separating machine has gone to greater mathematical lengths. Each of six assignees receives 31/252 of his patent rights. A seventh assignee gets the remaining 66/252. . . . CONVERTIBLE in only a few minutes' time for use by a man or woman, a bicycle designed by Cataldo Giambra, of New York City, has double utility. The upper bar of the frame has been made detachable, so that it may occupy either of the positions shown by solid and dotted lines in the diagram. To hold the bar in place, slotted connectors are used, and these are made rigid by screws tightened upon them. So little is the appearance of the bicycle changed by the convertible feature that it might be taken for a standard model.





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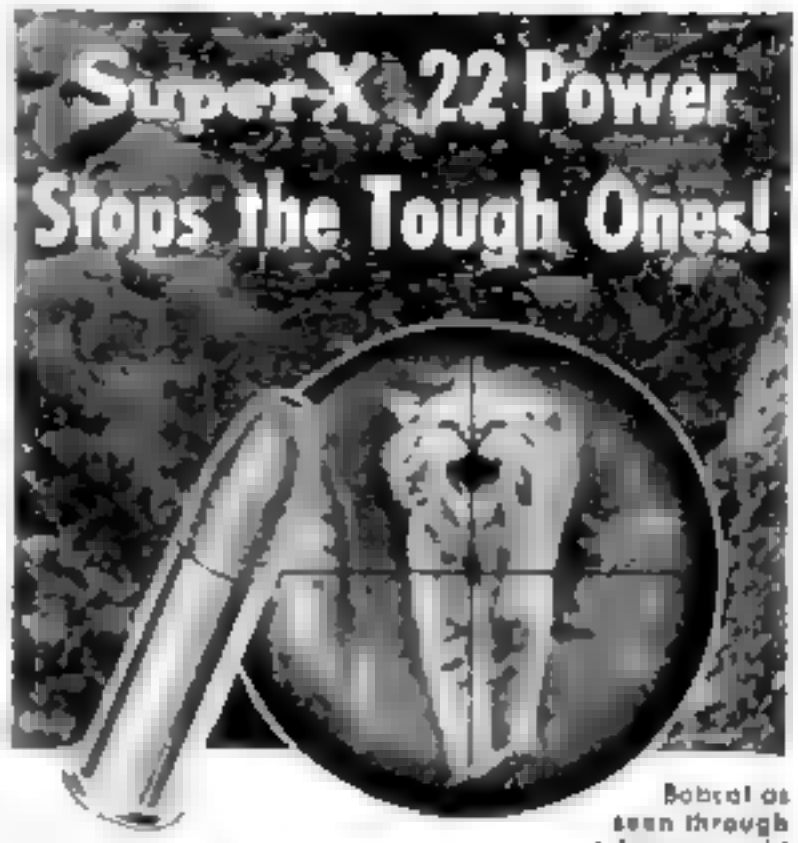

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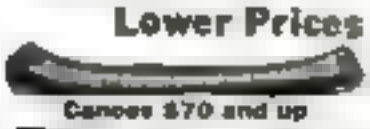
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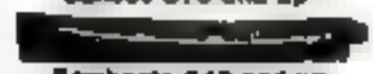
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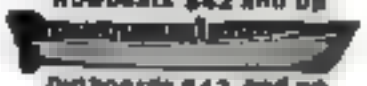
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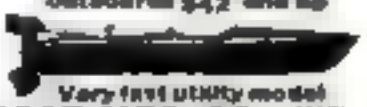
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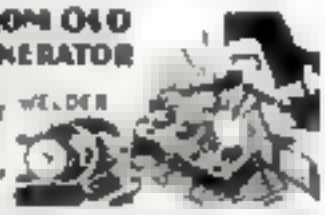

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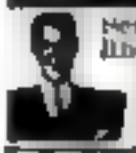

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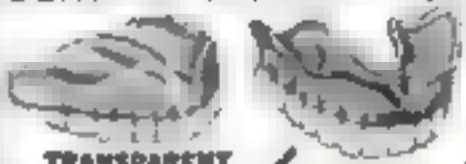

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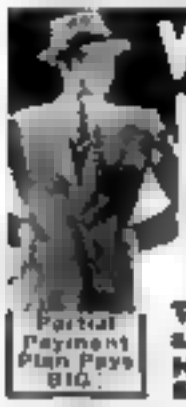

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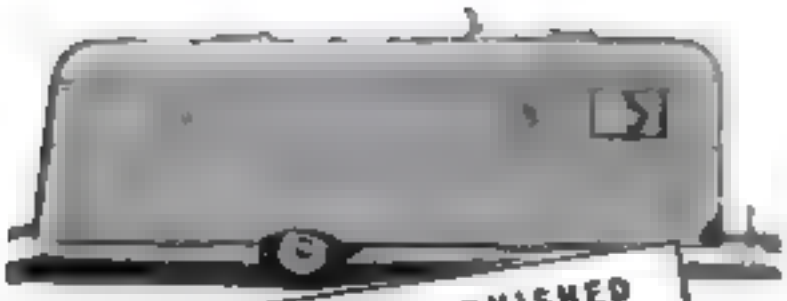

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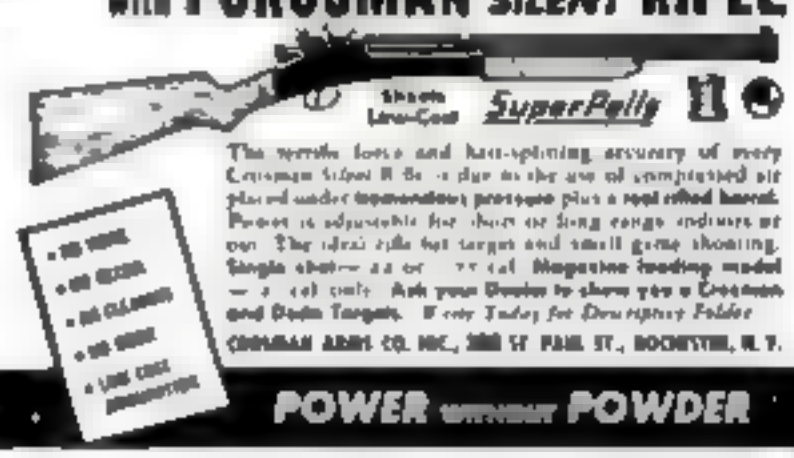

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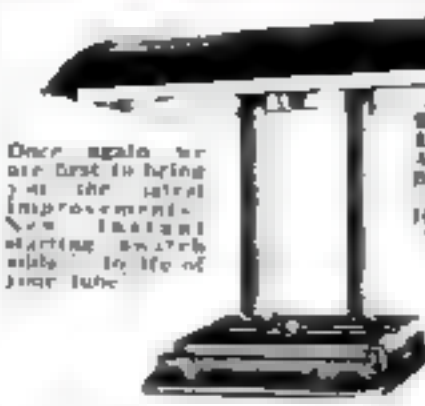

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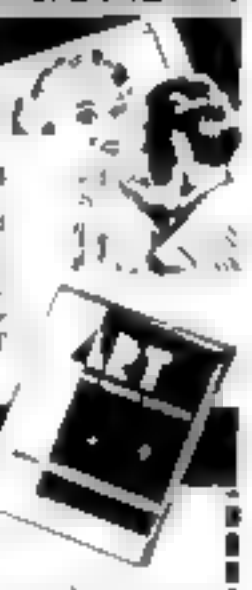

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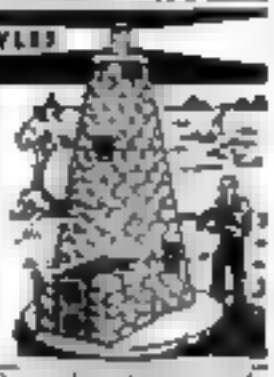

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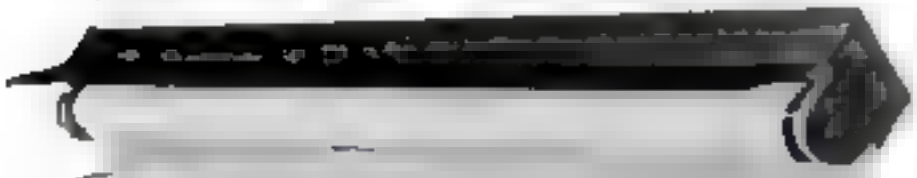

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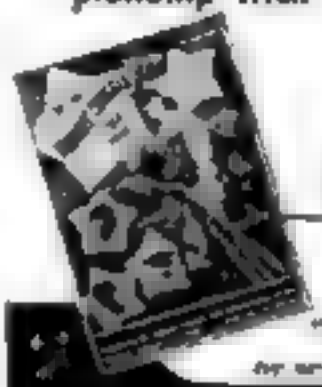

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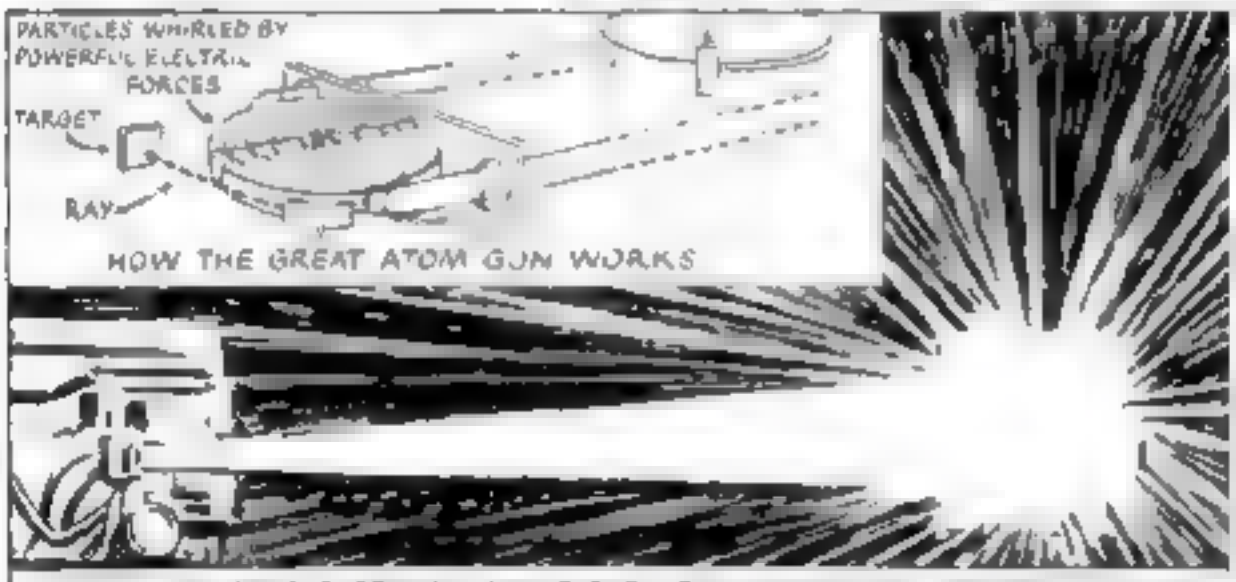
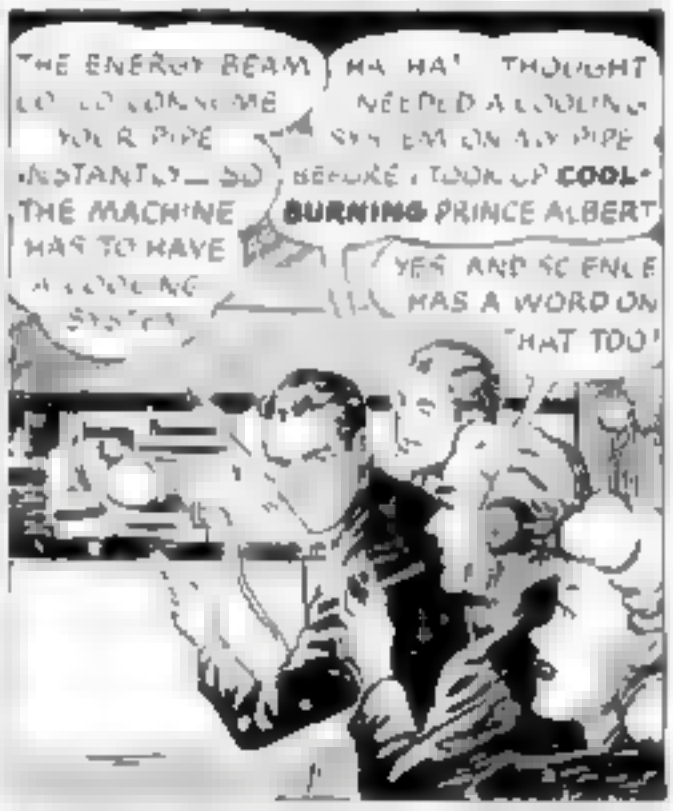


HEAVILY CHARGED PARTICLES SHOOT OUT AT 14,000 MILES A SECOND 35,000 TIMES FASTER THAN A RIFLE BULLET—IN A MYSTERIOUS BEAM THAT SMASHES AGAINST ATOMS IN A TARGET. THE IMPACT RELEASES ASTOUNDING ENERGY FROM THE ATOMS' CORES—FOR EXAMPLE 50 MILLION TIMES MORE POWER THAN FROM THE BURNING OF AN ATOM OF CARBON IN COAL. SCIENCE AMAZES HARNESS THIS POWER



Sky Cargoes

Porpoise Milk and Gizzardless Hens, Drill Bits and Salt Fish Travel by Airplane Nowadays

By CHARLES MORROW WILSON

AIR EXPRESS is the new bonanza of commercial aviation. In the United States last year more than 1,000,000 commercial shipments traveled by plane. They flew to 48 states, 31 nations, and five continents. They ranged in size from a mosquito egg (*Anopheles*, the malaria carrier) to a 33,500-pound edition of a national magazine.

Seventeen domestic airlines now carry more than 3,000 express parcels daily in the holds of 265 scheduled airliners, which fly to 269 American cities via about 43,000 miles of domestic airways. In ten years air express, first instituted in 1927, has grown about 5,000 percent. Average rates have been reduced 66 percent as cross-continent flying time has been reduced from 33 to 15 hours. The average air-express charge is now four cents a pound per hundred miles. The cargo is collected and loaded from the 23,000 domestic stations of Railway Express Agency.

The newest addition to the air-express service was started last February 25, when Pennsylvania Central Air Lines opened the first direct air route between Pittsburgh and Birmingham, via Wheeling, Knoxville, and Chattanooga. Late in February, the Civil Aeronautics Board authorized All American Aviation Lines to introduce a new air-ex-

The stewardess at the left is riding with a plane load of air express. Packages pay two cents a mile more than passengers

press service into New England this year.

LaGuardia Field, New York, has become the world's greatest port for air express. As many as 3,800 parcels have been flown from there during 24 hours. Packages air-expressed from New York arrive at Hong Kong in seven days, Buenos Aires in four, Honolulu in two. The heaviest air-express traffic is still between New York and Chicago, with three commercial airlines making 82 scheduled flights a day.

Today air express flies wherever men fly. From New York it crosses the Atlantic, touching four continents — 770 miles to Bermuda, thence 3,115 miles to Lisbon, thence 2,110 miles to Bolama in Portuguese Africa, another 3,120 miles to Trinidad and South America's Guiana coast, then 619 miles to San Juan, Puerto Rico, and 1,610 miles back to New York. From the Pan American Airways international ports at Miami, Brownsville, and Los Angeles about 150,000 air shipments a year are being flown to the 20 republics of Latin America. From San Francisco, air express rides wings to Hawaii, the Philippines, China, Australia, New Zealand, and the South Seas. From Seattle, Pacific-Alaska airliners with five-ton loads of passengers and express make bi-weekly flights into the frozen wilds of the Yukon Territory and Alaska.

While European air traffic spills fire, wreckage, and death upon

Air expressman sorts packages—a far cry from the stagecoach days of Wells Fargo

Loading a plane. Boxes on the truck contain cut flowers, many tons of which are shipped by air express

three continents, American aviation continues to carry peaceful commerce to all continents.

Air-express traffic is welded to air-passenger traffic, since it rides the same planes. But air express also leads us toward an era of air freight. Soviet Russia now claims world leadership in commercial air freight, with a reported 1940 total of 66,000 tons. Canada probably comes second, with at least 11,000 tons of mine equipment, bullion, furs, and supplies being flown north of the "civilization line," where there are no railroads or highways.

In Central America, air portage of freight is estimated at 4,000 tons a year, roughly two thirds of which is chicle, the basis of chewing gum. About 90 percent of the world's supply of crude chicle is now being flown out of the roadless jungles of Peten, the largest, northernmost state of Guatemala. Throughout the South American Andes, mining operations are largely dependent upon air transport to bring in workmen, machinery, and supplies, and to lift out the refined ores. Recently the Fawcett Airlines, operating in Peru, Bolivia, and north Brazil, pioneered plane delivery of livestock, making risky landings upon remote pastures and ranges hundreds of miles beyond railroads.

In the United States we still have about 30,000 communities which lack direct railway service. Our highways are overcrowded with truck transport. Demands for faster deliveries increase. Our current national defense program proposes to establish plane manufacturing facilities of 50,000 units a year. It now appears probable that the end of our present defense emergency will find between 25,000 and 200,000 planes and motors awaiting legitimate commercial uses. With these will be between 30,000 and 50,000 young pilots, flight engineers, radio and ground technicians, all qualified by up-to-the-min-

3,800 packages have been loaded in a day at LaGuardia Field, New York

ute military and technical training.

It seems reasonable to predict that America will not leave such hugely valuable talents and materials to rust and rot. History has proved that military aviation paves the way for a superior civil aviation. The first big-scale experiment in air express was made in 1919 with a Handley-Page bomber, then the biggest in use, built by the British to bomb Berlin. The proposed route was New York to Chicago. The venture failed when the twin-motored giant was grounded by storm, but eight years later the first commercial air-express route was actually opened between New York and Chicago. Today the War Department is contracting for an unrevealed number of fast cargo planes to be used exclusively for quick transport of military freight throughout the hemisphere.

Among our recent commercial developments in non-passenger aviation is All American Aviation, Inc., a Delaware air line which now operates five mail and parcel "pick-up" routes in six eastern states. Last January 6 the company opened its newest pick-up run, which covers the 206 air miles between Williamsport, Pa., and Pittsburgh. The run features non-stop loadings. The plane skims low over the loading point, reducing speed to about 110 miles an hour. Outbound cargo is placed upon a 20-foot-high ground station, and a 15-foot retractable arm is suspended from the sidehold of the plane. The copilot, or pick-up man, makes a grapple-hook connection with the load, swings it aboard the plane, and stows it in the carrying hatches. He makes deliveries en route by dropping goods from the plane, while speed and altitude are reduced. Mail and ordinary parcels are dropped at specified points in strong bags or insulated boxes. Fragile parcels are "eased down" with parachutes. Methods for improved transfer of cargo are being perfected. Planes can cover the Williamsport-Pittsburgh run in about two hours. There are 14 station towns along the route.

This development points to a time when much of our mail, perhaps all of non-local first-class mail, will fly without extra charge.

According to statistics of Railway Express Agency, which sponsors all scheduled air express in the United States, the average weight of an air-shipped parcel is about seven pounds. The largest entry is machinery, including airplane and auto parts, electrical supplies, oil-well and mine supplies, and hardware. This group comprises about 27 percent of all air express.

Sorting air-express matter at LaGuardia Field. After the packages are classified, they go . . .

Printed matter, including advertising, newspapers, and proofs, is second, with about 26 percent of the volume. General merchandise, including clothing, uniforms, shoes, hats, furs, and textile samples comes third, with about 12 percent. Motion-picture films make up about seven percent of the traffic, electrotypes and matrices about five percent, cut flowers about four percent, currency and bank documents about four percent, and news photographs a little more than one percent.

When you study the waybills you see astounding entries in air express: live alligators, stuffed lizards, bananas, queen bees, bridal veils, Brazil nuts, live wasps, lightning bugs, mosquitoes, live minnows to eat mosquito larvae, oxygen in drums, snow in dry ice, airplane propellers, human ashes, trained seals, live snails, diamonds, emeralds, pearls and gold, bank currency, baby chicks, and Ecuadorean humming birds.

Included in recent air-express cargoes

. . . handlers pass them through a door in the side of the airliner. Inside, they are stowed on . . .

by a conveyor system to the trucks which carry them to the planes waiting for loads. Then . . .

were a gizzardless hen for the World Poultry Congress at Cleveland, fresh porpoise milk for the University of Chicago, and two 1,000-pound shipments of drill bits for an American oil firm operating at Lima, Peru. From Hawaii to Puerto Rico, orchids and other tropical flowers are being air-expressed to United States markets, and tons of domestically grown flowers are being flown to markets throughout the hemisphere. Plane shipments of salt fish and sea foods show outstanding growth as Canadian and Yankee fishing industries set out to regain United States and Latin-American fish markets which have been lost by Scandinavia. Hundreds of tons of one-pound samples of coffee, wool, cotton and cotton seed; rice, barley, wheat, corn, cocoa, and other great crops are being flown to buyers and brokers.

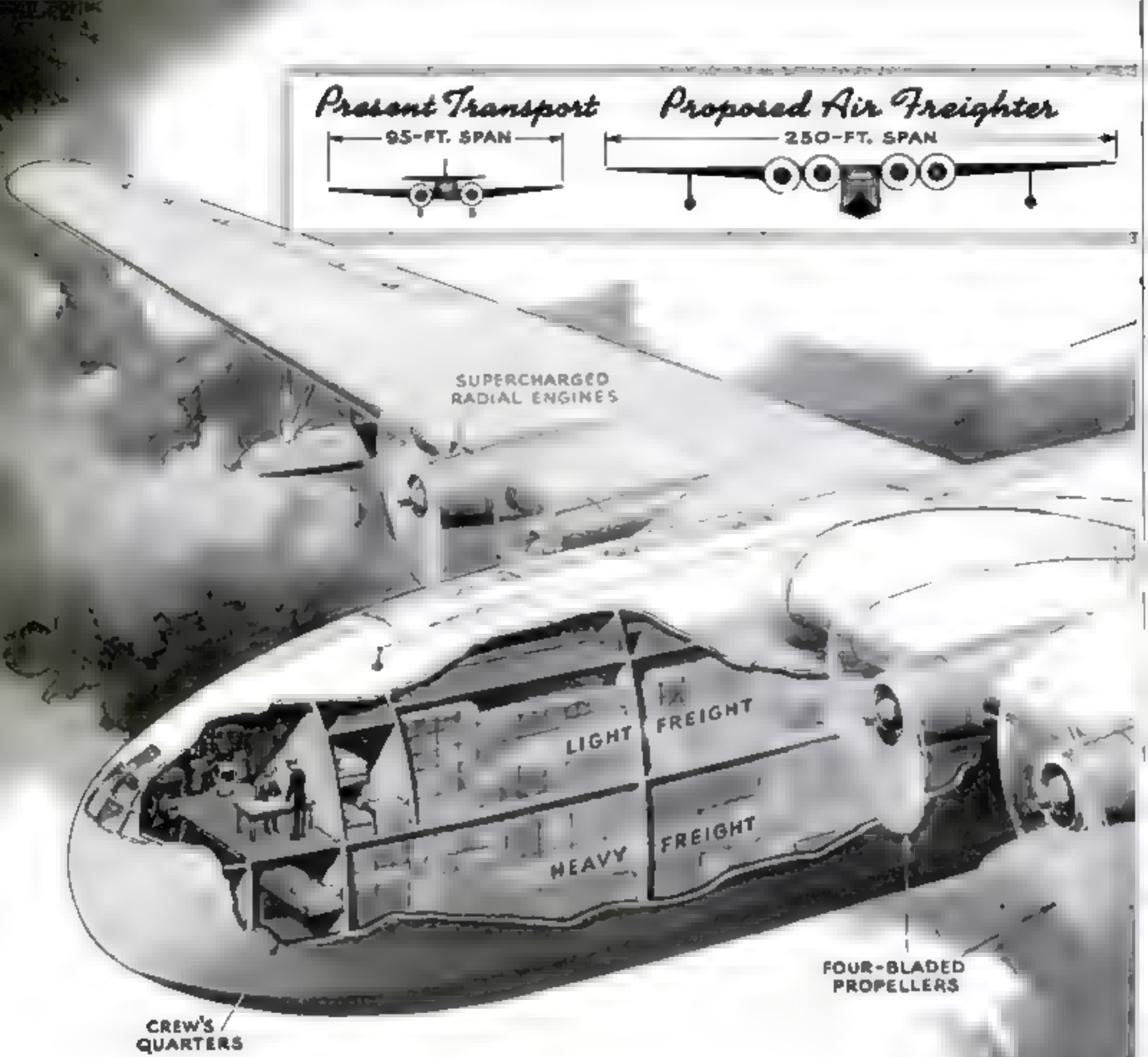
Vaccines, serum, surgical and dental supplies, human blood for transfusion are other increasing entries. Maine potatoes, Louisiana strawberries, Florida turkey, Wisconsin cheese, and Utah cabbages are among state "specialties" being air-expressed to far-away markets. Millions of beneficial insects for control of scale, rust, root weevil, and other crop diseases are being flown to and from 20 countries and four continents, since many of man's most valuable insect friends cannot be transported great distances by ship or rail.

Engine repairs are flown to broken-down ships thousands of miles from home ports. Recently Twentieth Century-Fox air-expressed 1,600 pounds of film and camera lenses to Argentina for making a South American film. The picture "Jesse James" was an air-express product. It was filmed at Noel, Mo., in the Ozarks, and each day the producers air-expressed about 3,000 feet of film back to Hollywood for studio approval and "retake" instructions. During 49 days of "shooting" about two tons of film were flown to and from Hollywood. The "Birmingham Daily News" and the "Miami Herald" are among the first daily newspapers of the United States to use air express for regular deliveries. The "News" is delivered at the Birmingham airport at 2.10 p.m., and by 3:15 it is on sale at Montgomery, Alabama's capital, 86 miles away. The "Miami Herald" air-expresses an edition to Havana.

The longest air shipment on record was made last year, when about 500 pounds of air express traveled from Montreal to San Francisco, thence by Hawaii Clipper plane to Tientsin, China, and thence by Empire plane to Calcutta, India, for an air haul of 18,000 miles in nine days. The shipment contained wool felt, an essential in manufacture of certain types of paper.

The largest air-express shipment was made on November 6, 1940, when 1,216 packages of the magazine "Newsweek," weighing about 33,500 pounds, were flown from Dayton, Ohio, where the magazine is printed, to every state and all provinces of Canada. The issue went to press at 10.00 a.m. At 12:20 a TWA plane took off for Pacific Coast cities with 3,600 pounds of the magazine aboard. Within 12 hours, 15 additional plane loads were lifted, with a maximum load of 5,000 pounds per plane. By business hours next morning the magazine, which carried complete news of the national election, was on sale at newsstands in every important city of the United States. By coincidence, this record shipment marked the thirtieth anniversary of air express in the United States.

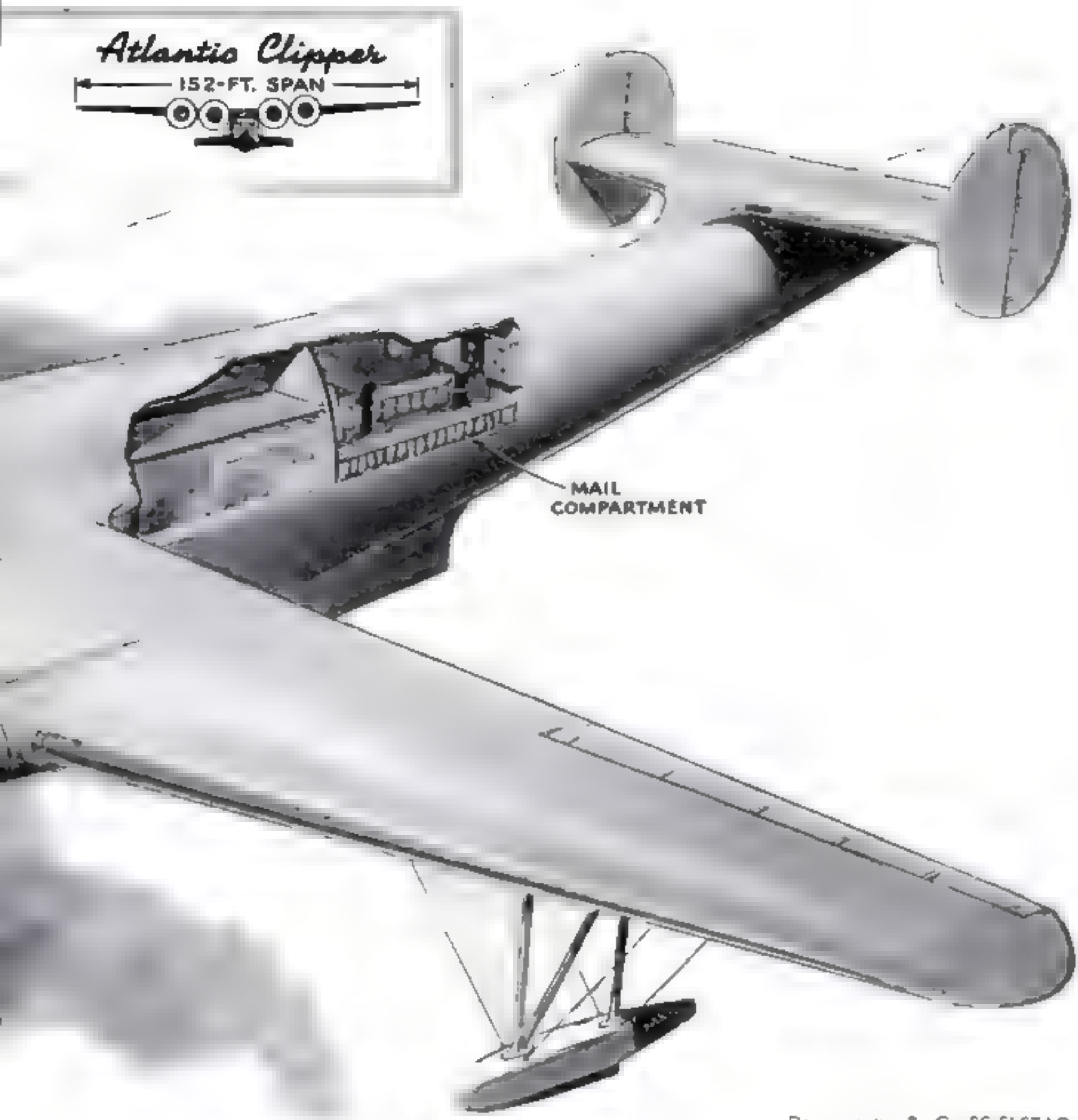
seats intended for passengers, but now covered so that better-paying cargo won't scratch them



Tomorrow's Freighters

FREIGHTERS with wings, hauling 80-ton cargoes 3,500 miles without a stop, are more than an aviator's dream. According to Glenn L. Martin, Baltimore airplane manufacturer, they are a logical development of the aviation industry. The construction of planes capable of such performance, weighing 380,000 pounds, could be started tomorrow if somebody should order one.

Paradoxically, the destruction of the present war will speed the development of air freighters, their size to be determined by the business available, Martin believes. This is because the war is teaching airplane manufacturers to turn out bigger, better, and speedier planes by mass-production methods. It is pushing aeronautical research far beyond the point to which it would have progressed under more normal conditions in an equal period of time, and at the same time is destroying sea-borne cargo carriers at such a rate that a serious shortage already exists. Thus, when the war ends, exporters can be expected to turn to the air for a means of transportation that can be produced rapidly to replace the lost ships, and will also get the freight to its destination faster than would be possible by any



Drawing by B. G. SEELSTAD

method of transportation on land or water.

Martin, who flew an early "air express" in 1912 when he carried newspapers and mail in a plane, and whose factory has turned out some of the world's biggest planes, is not telling what the detailed specifications of a 190-ton air freighter would be. But he already has the drawings for a 65-ton luxury passenger airliner, a step in the right direction, and his factory is building a plane, presumably a bomber, which will be the U. S. Navy's largest flying boat.

He has no fear that postwar conditions will cause a slump in the aviation industry. Before the war began, he points out, it was the nation's fastest-growing industry. War-stimulated growth will enable it to pick up commercial plane production when the war ends years ahead, in progress, of where it would otherwise have been.

The not-far-distant future will see a system of harbors, landing fields, docks, and warehouses serving air freighters as railroads and ships are now served, Martin believes. He sees in air freight a new frontier for Americans, with thousands of new jobs for workers and vast new fields of investment for capital.

When Edward G. Robinson places his forefinger on the end of his nose, like this, he is bragging that the broadcast has been completed within five seconds of the allotted time. Ona Munson, who costars with him in the "Big Town" series, smiles agreement

Signs and Slang Form Radio's Lingo

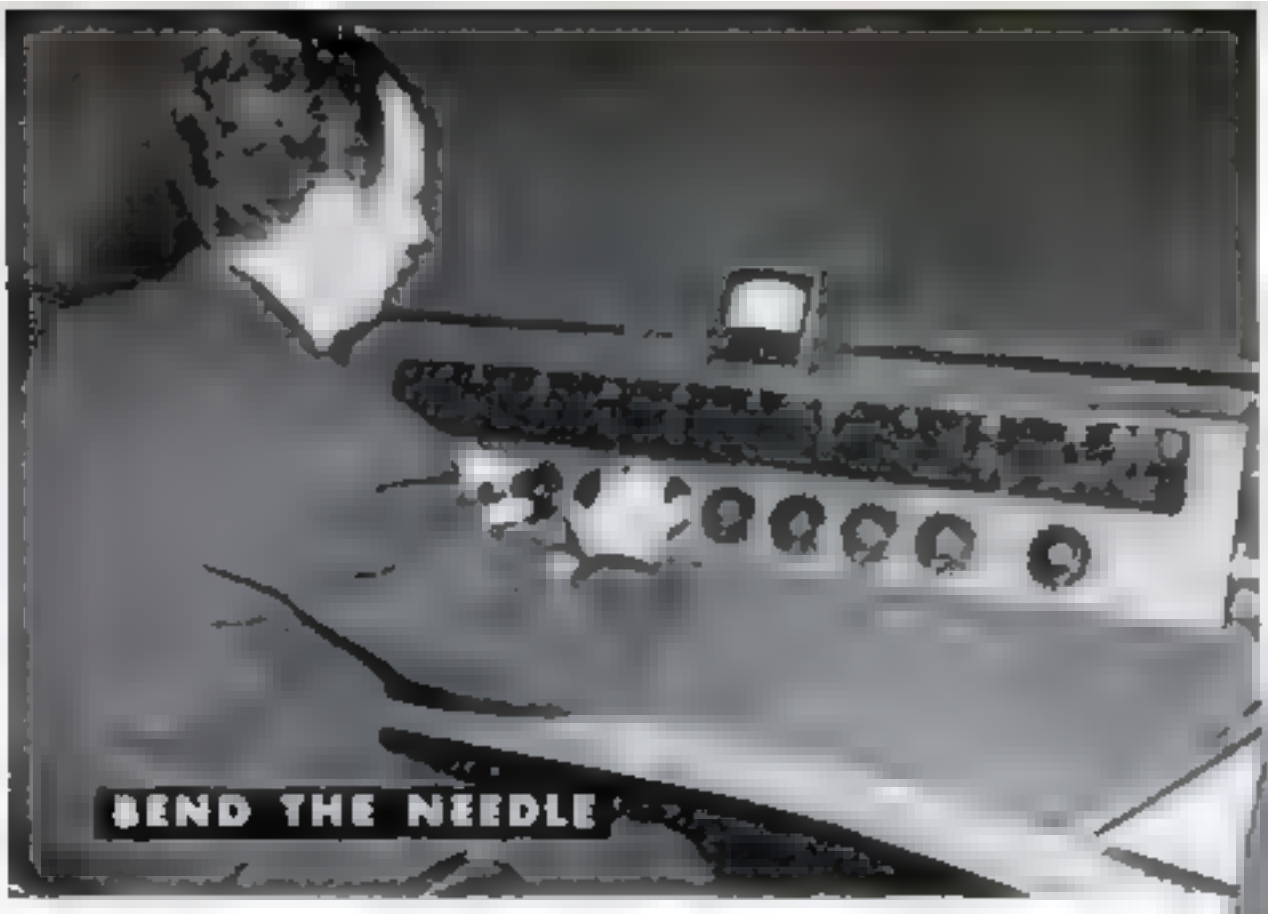
For muffled effects, such as a voice from inside a box, an actor talks into the rug — usually the big end of a megaphone. Or sometimes, he turns his back to the mike and speaks into sound-absorbing draperies

"CALL OUT the Marines! Battle from the pancakes!" It's not a military commander speaking, but the director of a radio show calling for the sound of marching feet and a canned street brawl complete with shouts and wailing police siren

Radio directors, actors, and technicians use a strange jargon to make themselves understood. And, because silence literally is golden in the studios, they have a sign language just as weird as their speech.

The photographs on these pages, snapped by a POPULAR SCIENCE cameraman during a rehearsal in Hollywood for the popular radio drama "Big Town," give you an idea of the signs and slang of the broadcast studios

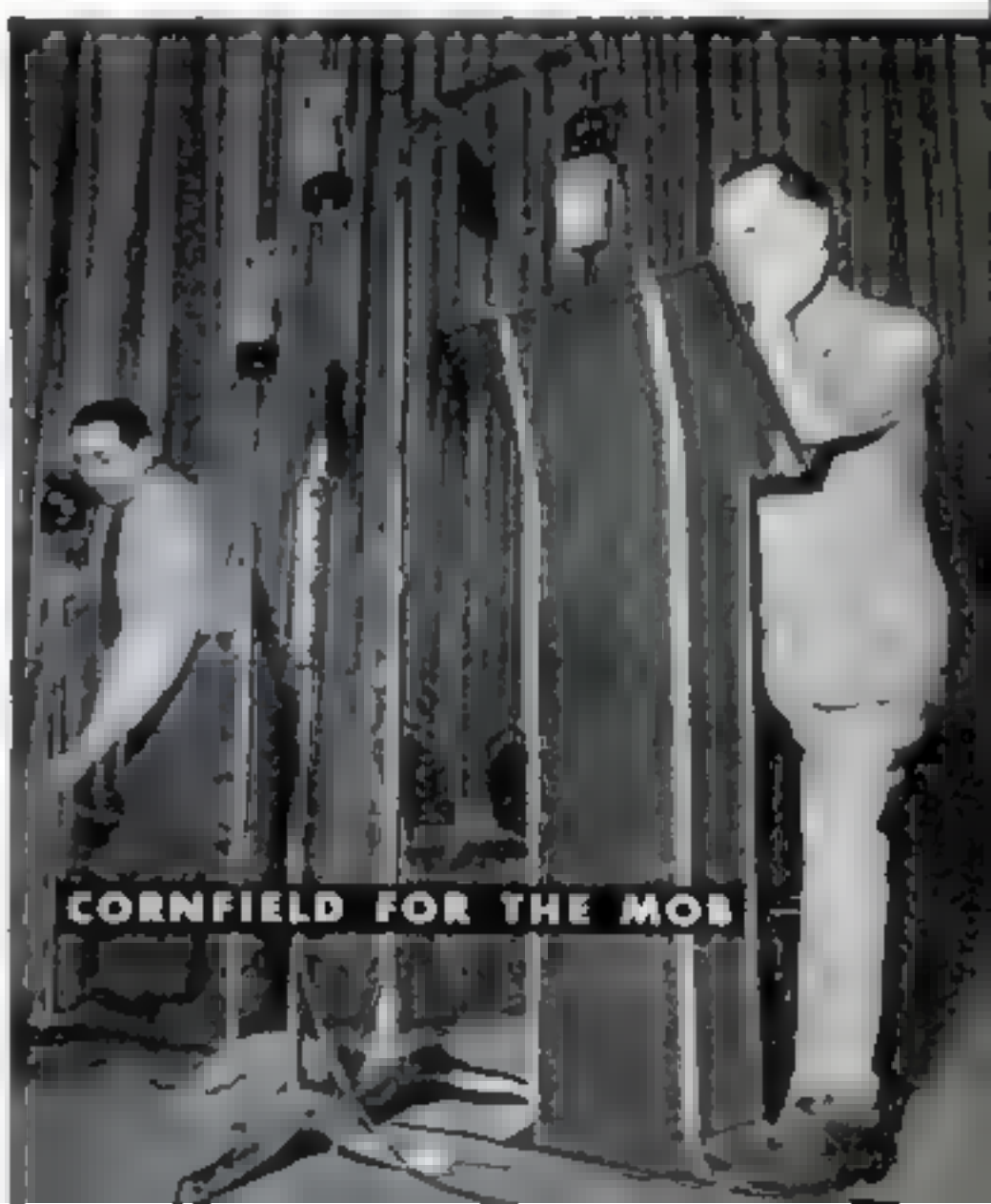
POPULAR SCIENCE



In the control room, the sound mixer keeps one eye on his dials and the other on the actors and sound-effects crew. He is supposed to keep the volume needle steady in order to put the program on the air properly. If he slips up, he "bends the needle"

If the director sees that the show is moving too fast, he signals to "stretch it," by drawing his hands apart thus. Then the orchestra may play a few extra bars, or the announcer add a paragraph or so to the "commercial"

When the script calls for the sound of marching feet the director "calls out the Marines," and a gaffaon, or sound-effects man, works this machine in which nine blocks of wood hung on rubber bands strike a plywood base in measured marching cadence



For crowd scenes where individual voices are to be distinguished, the "cornfield for the mob" brings four or more microphones together in a row. "Big Town" uses 900 recorded sound effects, 1,500 mechanical ones

Chemically treated potatoes, at right, do not sprout when stored at room temperatures. Untreated potatoes, below, have sprouted. Another treatment ends dormancy

Photos by William Morris

MIRACLES OF THE PLANT CHEMIST

Experiments Promise New Control of Farm and Garden Crops, by Means of Chemicals that Speed Up or Retard Growth Activity.

CHEMISTRY, in the hands of experimental botanists at the Boyce Thompson Institute for Plant Research, Yonkers, N. Y., is providing science with new methods for the control of farm and garden crops. By means of "stop and go" chemicals, the Yonkers research men govern the activity of plants. With vapors, sprays, and fluids—used on an experimental scale—they are able to halt the blooming of orchards, prevent winter potatoes from sprouting even at room temperatures, cause fruit to set without pollination, prevent the premature dropping of apples, and make seeds lie dormant or send out sprouts.

Two chemical compounds, methyl ester of napthaleneacetic acid and ethylene chlorhydrin, are used most frequently. Like the brake and the accelerator on a motor car, these chemicals slow down or speed up activity in leaves, buds, seeds, and trees. This plant magic, the result of years of experimentation, has many practical applications.

Tests at the laboratory have proved that a

A normal hibiscus leaf (upper left) and curious variations produced when the new hormonelike chemical, naphthoxyacetic acid, is placed on the growing plant. It also will cause fruit to set without pollination

simple chemical treatment of potatoes eliminates the need of refrigeration and permits the tubers to be kept, without sprouting, at ordinary room temperatures. Methyl ester of naphthaleneacetic acid is mixed with alcohol to make a one-percent solution, and the resulting fluid is soaked up with paper towels. Four grams of the ester, dissolved in one pint of alcohol, are used for each bushel of potatoes. As soon as the alcohol has evaporated, the treated towels are placed on top of the tubers in a crock or barrel and covered with newspapers. The chemical action, penetrating downward, will keep the potatoes dormant for a year or more.

At present, this compound is rather expensive. But increased production would cut the cost and make it readily available. If the potatoes are desired for planting, dormancy can be broken in the spring by a second chemical treatment. After being cut, the tubers are placed in a closed container and subjected to the vapors of ethylene chlorhydrin for 24 hours.

An additional discovery made by Dr. John D. Guthrie, who carried out the potato experiments, is that he can make winter twigs of pear and other trees produce leaves and an increased number of buds in the laboratory simply by injecting the chemical compound, gluthathione. Ethylene chlorhydrin will achieve the same result, he has found.

Every year, American orchardists lose thousands of dollars because late frosts nip the buds of early-blooming fruit trees. This waste may be eliminated if a chemical treatment, which has proved successful in the laboratory, can be applied to full-scale operations. For two years, Drs. A. E. Hitchcock and P. W. Zimmerman have been experimenting at the Yonkers laboratory with various chemicals in an effort to control the blooming of fruit trees. So far, methyl ester of naphthaleneacetic acid functions best. Twigs, treated with it just as the buds begin to show color, delay blooming for from a few days to two weeks. So exact is the effect of this treatment that the scientists can pick out one bud and hold it back while permitting the others on the twig to bloom.

Another interesting application of naphthaleneacetic acid has been developed by Dr. F. E. Gardner, of the United States Department of Agriculture. He uses it to pre-

Cutting up blueberry twigs for rooting. To keep them dormant through the winter, they are stored at about 40° F. At right, cuttings are being dipped in root-producing hormodin

vent premature dropping of apples. When the fruit begins to ripen in the fall, a layer of cells at the base of the stem commences to separate, eventually cutting the apple free. If this occurs before the fruit can be picked, bruising and loss result. Naphthaleneacetic acid and its derivatives, Dr. Gardner reports, slow down the action of the cells and prevent early dropping of apples. In this case, as in the delaying of blooming, the present stumbling-block to practical application is the cost of the chemicals.

For generations, an agricultural mystery has concerned the reason why many seeds, carried south and planted in warm climates, produce only stunted trees. Peach trees grown in the South do not develop well because the buds on the trees likewise need months of cold to break their dormancy. Pear, peach, apple, plum, and cherry seeds have been placed for one month, two months, and three months in refrigerators at the Boyce Thompson Institute. After being subjected to a constant temperature of about 40 degrees F., they have been removed and planted. The first group produced only a few sprouts; the second group, more; and the third group—which had received three months of cold treatment—had almost a perfect score.

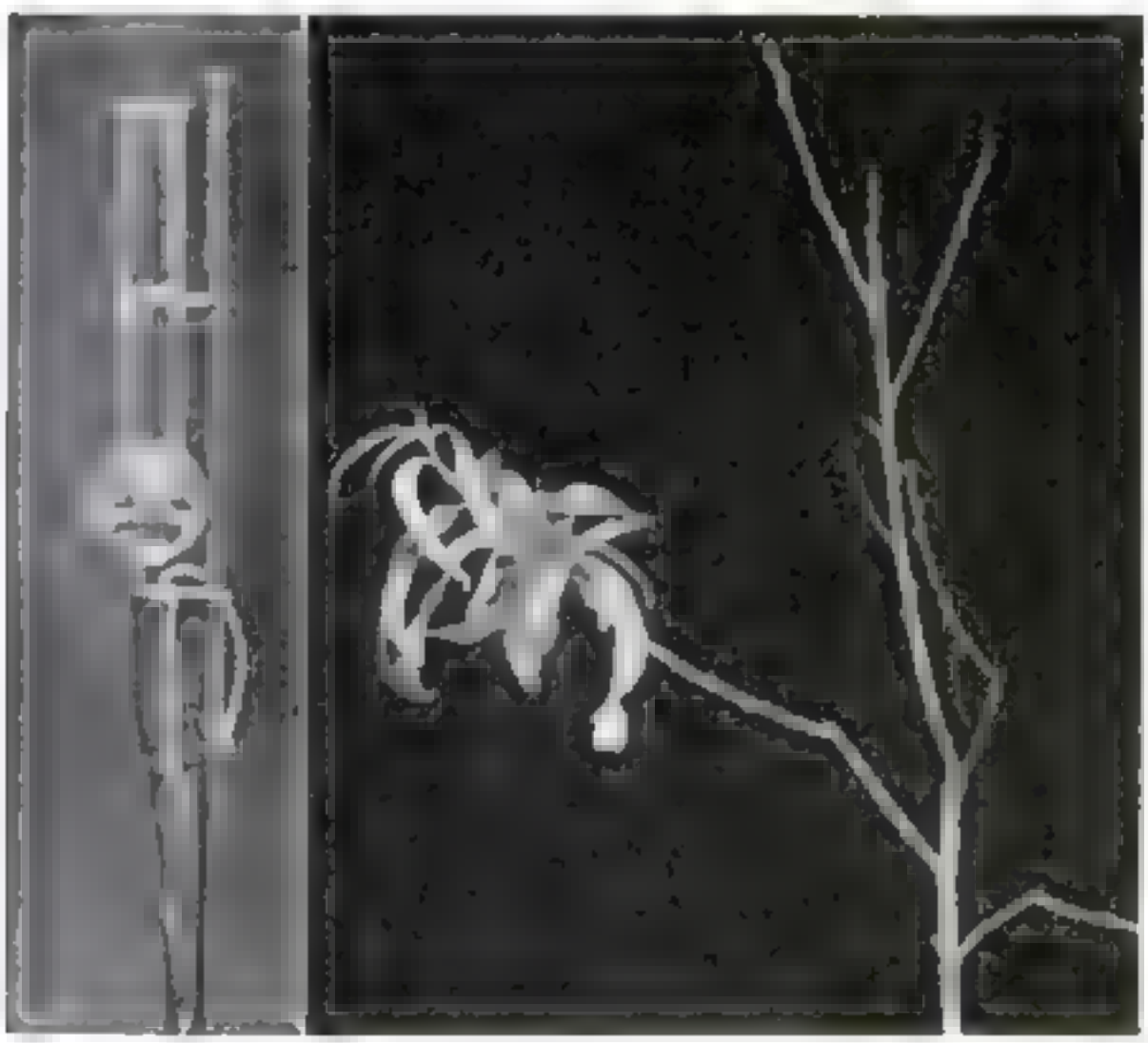
Research at Yonkers in the field of those mysterious growth-inducing substances, plant hormones, forms a serial story of science. The latest chapter has been added by Drs. Zimmerman and Hitchcock. To the list of some fifty compounds already known they have added another, naphthoxyacetic acid. It requires three hours, and half a dozen steps, for a skilled chemist to prepare this hormonelike compound.

Fifty grams of beta-naphthol and 24 grams of potassium hydroxide are dissolved in 450 cubic centimeters of distilled water; and 33 grams of chloracetic acid and 24 grams

of potassium hydroxide in 250 cubic centimeters of distilled water. These two solutions are mixed and heated for an hour with a reflux condenser. As the mixture cools, potassium naphthoxyacetate precipitates. Four grams of this salt are added to 50 cubic centimeters of ethyl alcohol and shaken, after which 40 cubic centimeters of five-percent sulphuric acid are poured in to dissolve the precipitate. When 250 cubic centimeters of water are added, beta-naphthoxyacetic acid precipitates out.

This magic dust is worth the effort required in its production. Besides causing cuttings to take root quickly, it produces mystifying effects of many kinds. Roots grow on flowers, fruit sets without pollination, stems develop curious bunches and swellings, leaves alter their customary shape, when plants are treated with this compound. This new discovery has provided the Yonkers research men with still another aid to their search for new ways for regulating the activity of the world's first chemical factory —the growing plant.

Peach seeds require months of winter cold in order to produce normal trees. The dwarf plant at right, above, came from a seed that had not received cold treatment; the larger plant, from a seed kept for three months in a refrigerator at about 40° F.

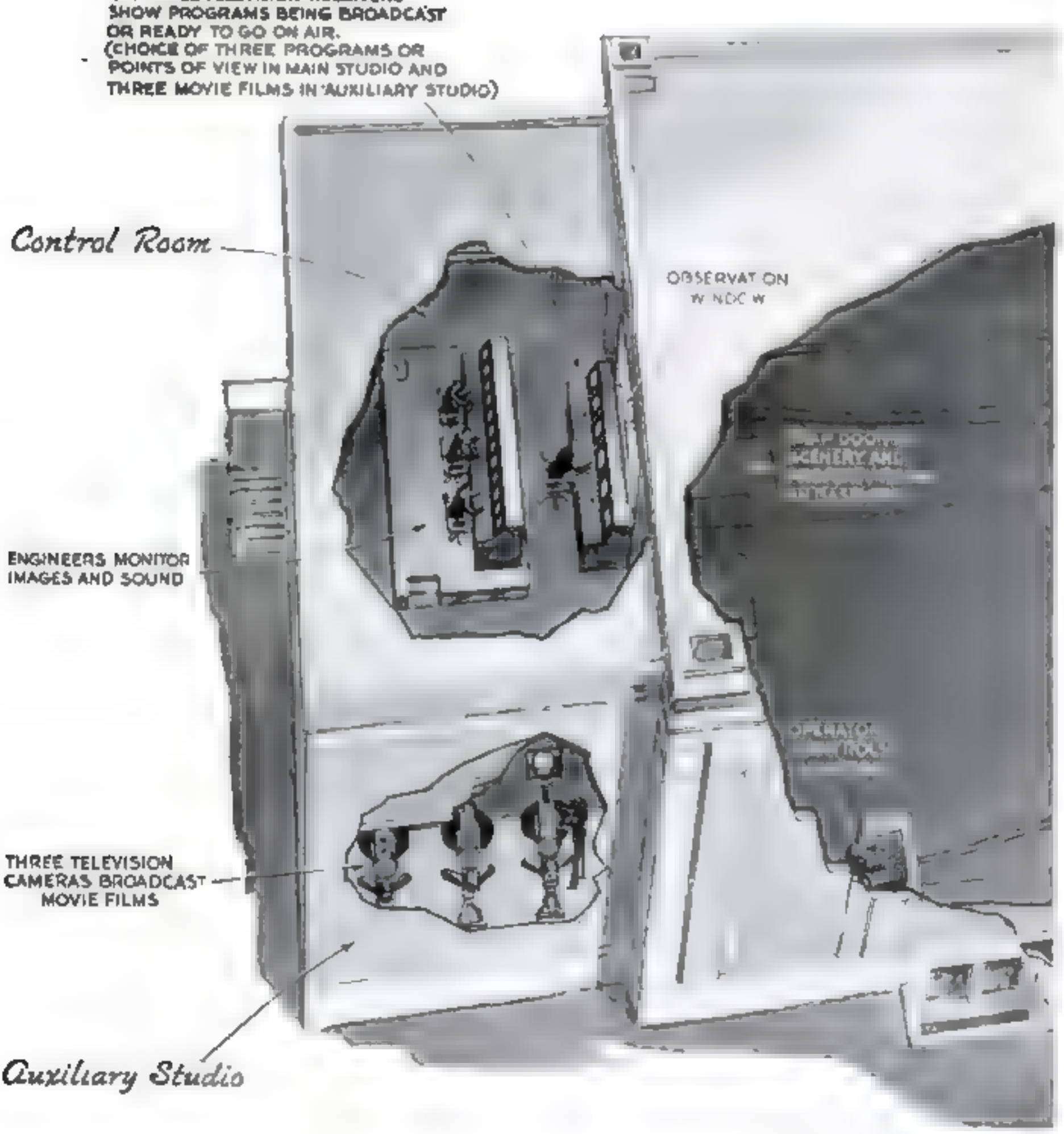


The drying tube at the far left holds chemicals which are gradually injected into the twig of a plant in a laboratory test. Glutathione, injected in this manner into the tagged peach twig shown in the accompanying photograph, caused an increase in the number of buds and speeded up the formation of leaves

A Model Studio Is Built For Television

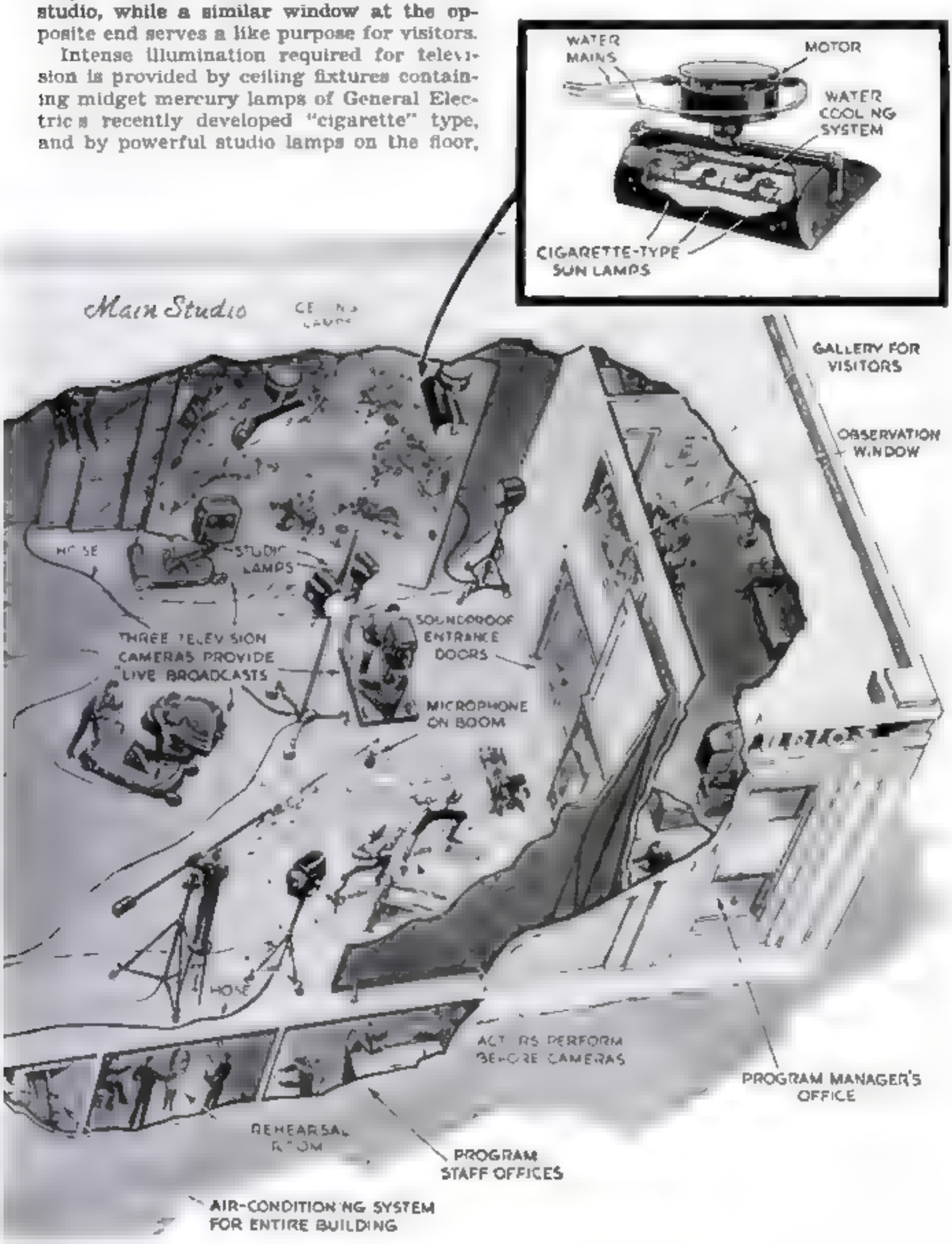
WHEN the new television broadcasting studio of the General Electric Company station W2XB goes into service, in late spring or early summer, it will represent the last word in image transmission. A large remodeled clubhouse at Schenectady, N. Y., houses facilities unavailable in outgrown quarters. Transmitting equipment employs a battery of six television cameras. Three of them pick up scenes in the main studio, a soundproofed room measuring 70 by 46 by 18 feet and occupying most of the main floor.

The cameras may be focused on a single scene, from different angles and distances, or may be used on different sets of the big



stage. An auxiliary studio contains three more cameras for telecasts from movie film. In a control room, radio engineers monitor sight and sound. They switch from one camera to another, aided by six screens showing what is on the air and what is ready. Through a large observation window, they command a direct view of the main studio, while a similar window at the opposite end serves a like purpose for visitors.

Intense illumination required for television is provided by ceiling fixtures containing midget mercury lamps of General Electric's recently developed "cigarette" type, and by powerful studio lamps on the floor, both water-cooled. The entire building is air-conditioned for comfort. A 125-foot-tall antenna will relay the programs to the main transmitter in the Helderberg Mountains, 12 miles outside of Schenectady. In winter, this antenna will be heated electrically to prevent ice formation.



22nd INFANTRY

2nd AVIATION WING
G. H. Q. AIR FORCE

17th INFANTRY

WEST POINT

38th INFANTRY

26th INFANTRY

Heraldic Designs

Form Army's Regimental Insignia

TO MOST CIVILIANS the gayly enameled metal regimental insignia worn on lapels and hats of enlisted men and officers of the U. S. Army are mere decorations, but to students of heraldry and to the men of the service they tell, through symbolism, the glorious history of the regiments.

By inspecting the insignia, one versed in heraldry can often tell where and when the regiment was formed, its branch of service, and some of the major victories in which it participated.

Twelve typical insignia have been reproduced in color on these pages. All are now being used by Regular Army regiments and by Federalized units of the Army reserve.

The five crossed arrows on the shield of the 22nd Infantry tell of the five important Indian wars in which this regiment fought. Under these crossed arrows is the representation of a five-bastioned fort, stormed by the regiment in Cuba during the Spanish-American War. (The 22nd was the first infantry unit to land in Cuba during that war.) There is also the blazing sun emblem, a Katipunan symbol indicating service during the Philippine Insurrection. (Katipunan is the name of a Filipino revolutionary society.) Blue and white denote infantry

The griffin, part eagle and part lion, rep-

25th FIELD ARTILLERY

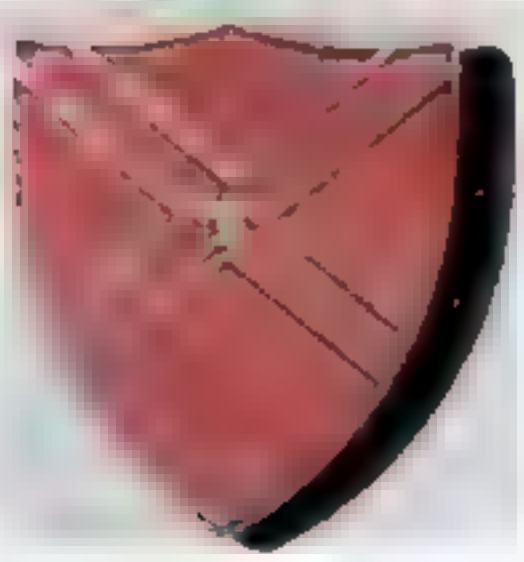
9th FIELD ARTILLERY

10th FIELD ARTILLERY

13th COAST ARTILLERY

41st C. A. C. BRIGADE

69th COAST ARTILLERY



Traditional symbolism in these insignia, worn on soldiers' lapels and hats, embodies regimental history

resents mastery over both air and land, and as such was adopted by the 2nd Aviation Wing, G. H. Q. Air Force. This unit, stationed at Langley Field, Va., was the 2nd Bombardment Wing formed after the World War.

Part of the Army of the Potomac during the Civil War, the 17th Infantry still retains the white cross pattee that was the symbol of Sykes' Army at Fredericksburg (Pattee is a heraldic term meaning narrow at the center and expanding at the extremities.) Again, there are two representations of the five-bastioned Cuban fort, to indicate where the regiment served during the Spanish-American War.

Since the founding of the United States Military Academy at West Point, N. Y., the golden helmet and sword of Mars, Roman god of war, has been its symbol.

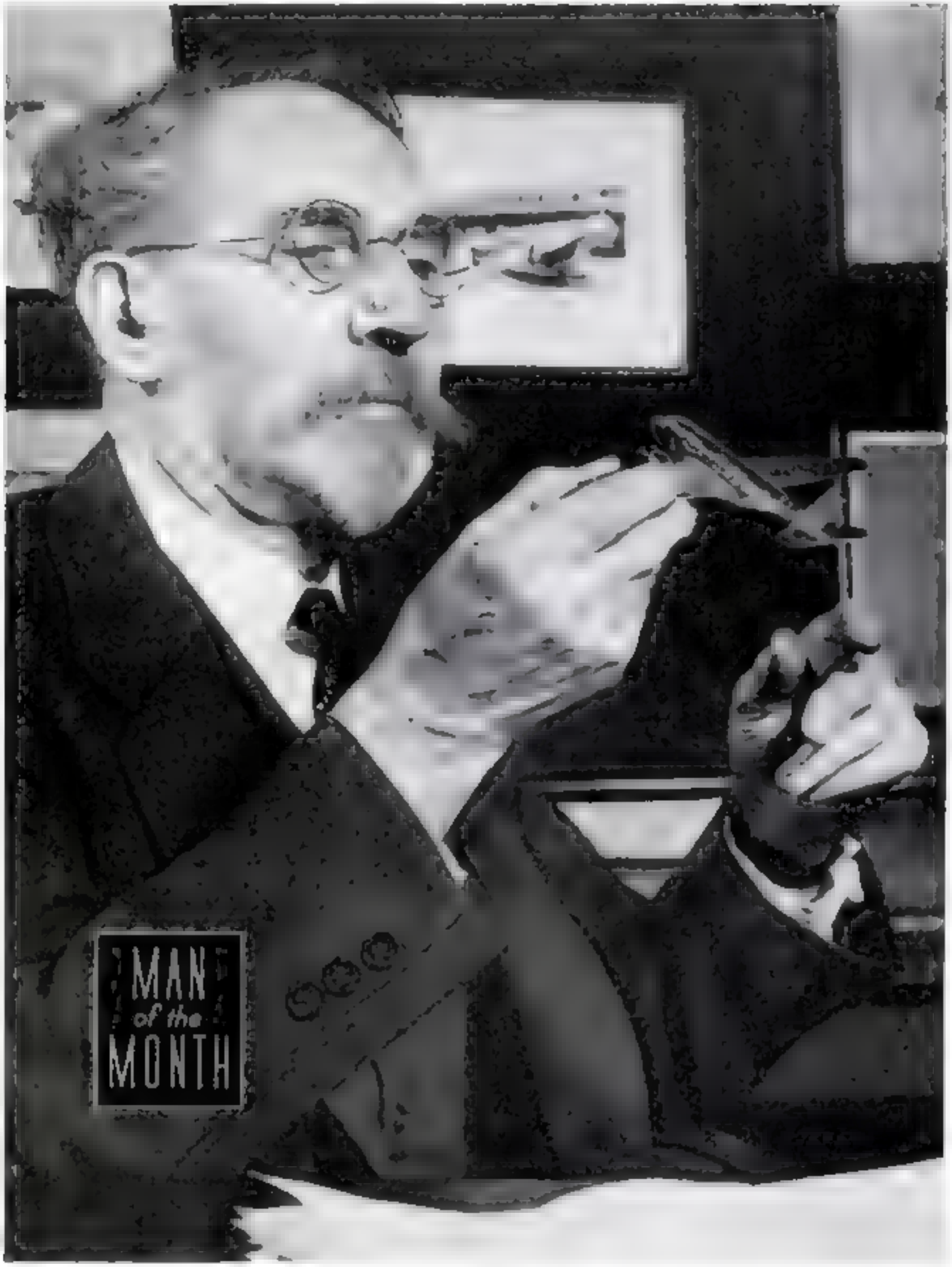
The 38th Infantry earned its designation, "The Rock of the Marne" early in June 1918, when it stopped the spearhead of the German offensive there. This battle is noted by the broken white bar, and three other major victories are noted by the three diagonal white bars. Above the shield is the rock.

The blue Mohawk Indian arrowhead was selected by the 26th Infantry during the World War as a symbol of courage. The armed sea horse of the 25th Field Artillery, at Fort Buchanan, Porto Rico, shows that it is an island regiment.

Both the 9th and 10th Field Artillery are now at Fort Lewis, Wash. The 10th participated in the second battle of the Marne, and a representation of "the rock of the Marne" is above its crossed cannons. The winged horse, Pegasus, indicates that this regiment used horses during the World War.

The 13th Coast Artillery is a Florida unit stationed at Fort Barrancas. The fleur-de-lis, a symbol of France, indicates that many members had served overseas before the unit was organized in 1924.

The motto of the 41st Coast Artillery Corps Brigade, a Federalized Reserve unit, means "above and beyond." The 69th Coast Artillery, an antiaircraft and coastal-defense unit, is stationed at Fort Crockett, Tex.



Dr. Sanford A. Moss, who found the secret of high flying and speed for modern civil and military planes

He Harnessed a Tornado...

and developed the modern airplane supercharger

By HICKMAN POWELL

PROBABLY the happiest man in America today is Dr. Sanford A. Moss, the man who developed the supercharger, the device which makes possible the altitude, speed, and range of the modern airplane.

His greatest creation, the turbo-supercharger, at last has come into its own, after twenty years of delay, as a basis for stratosphere flying. It has become one of the most important focal points in America's sudden war effort. No effort or expense is being spared to push its mass production. At last the sky is really the limit.

Twenty-three years ago, in order to help beat the Kaiser, Dr. Moss harnessed up a red-hot tornado, sheathed it in heat-resistant metal, and hitched it up to a Liberty motor at McCook Field, Dayton, Ohio. Sheltered behind a barricade of sandbags, he opened the throttle up wide. With a wild roar of broken connecting rods the airplane engine disintegrated. The spark plugs tore out through the roof.

Dr. Moss, a small scientific gentleman with a Vandyke beard, knew perfectly well what he was doing in this seemingly irrational behavior, just as any airplane pilot today knows that you are likely to tear your engine to pieces if you open up wide at sea level with a Moss supercharger. He was giving the turbo-supercharger its first demonstration, and he did his violent deed at the insistence of a skeptical group of Air Corps engineers, to convince them that this odd contraption of his was worthy of an official test at the top of Pike's Peak, in the rarefied atmosphere it was built to conquer. At half throttle they had refused to be convinced.

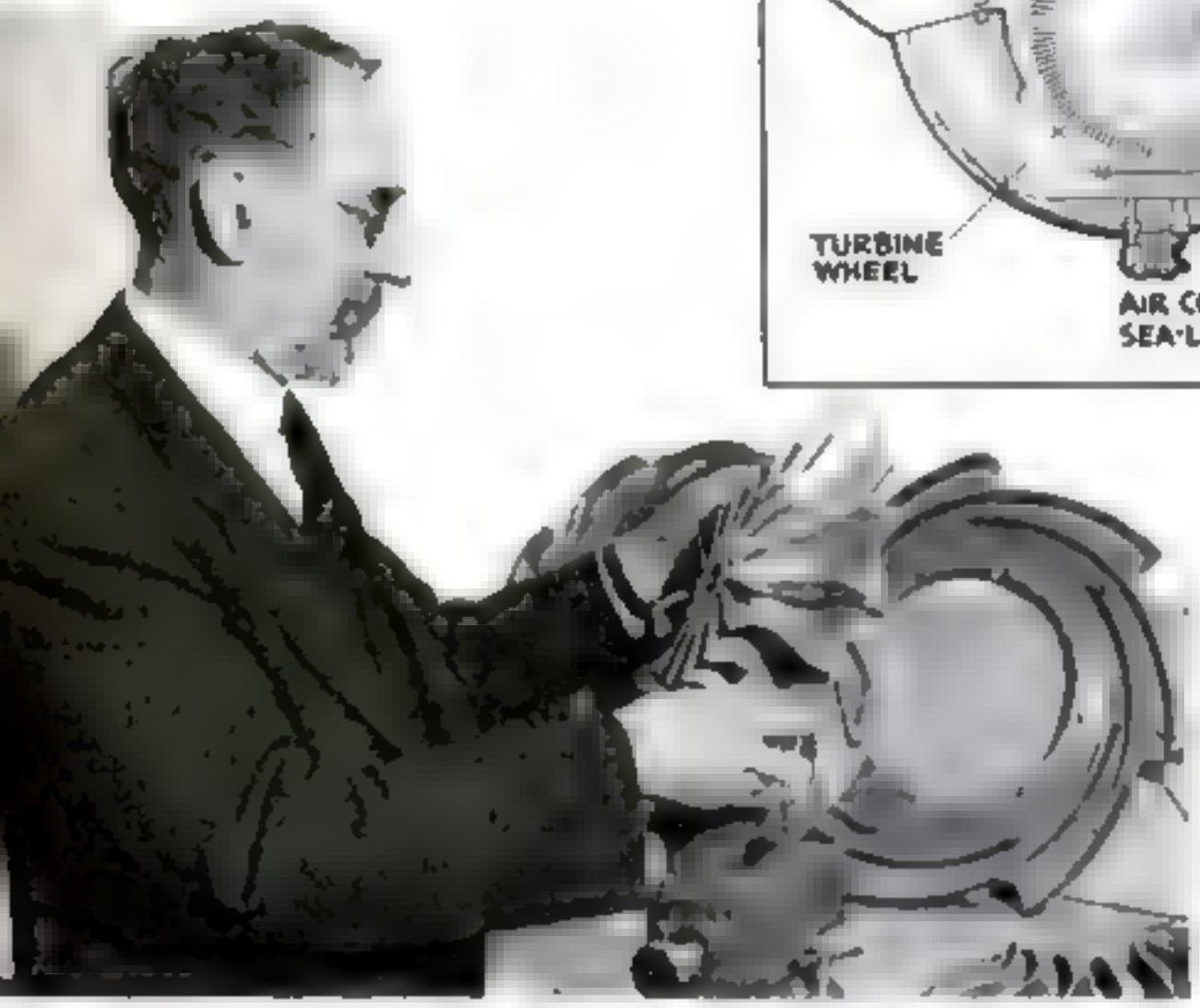
On Pike's Peak, in September, 1918, the turbo-supercharger proved itself. In those days an airplane engine lost power rapidly as it gained altitude because, as atmospheric pressure fell, less oxygen was sucked in to mix with the fuel in the combustion chambers. The supercharger was a centrifugal compressor, or fan, which forced air in sea-level quantities into the engine's carburetor. In the words of Dr. Moss, it "kidded the engine into thinking it was at sea level." The compressor was revolved by a turbine driven by a whirlwind of flaming fumes from the engine's exhaust.

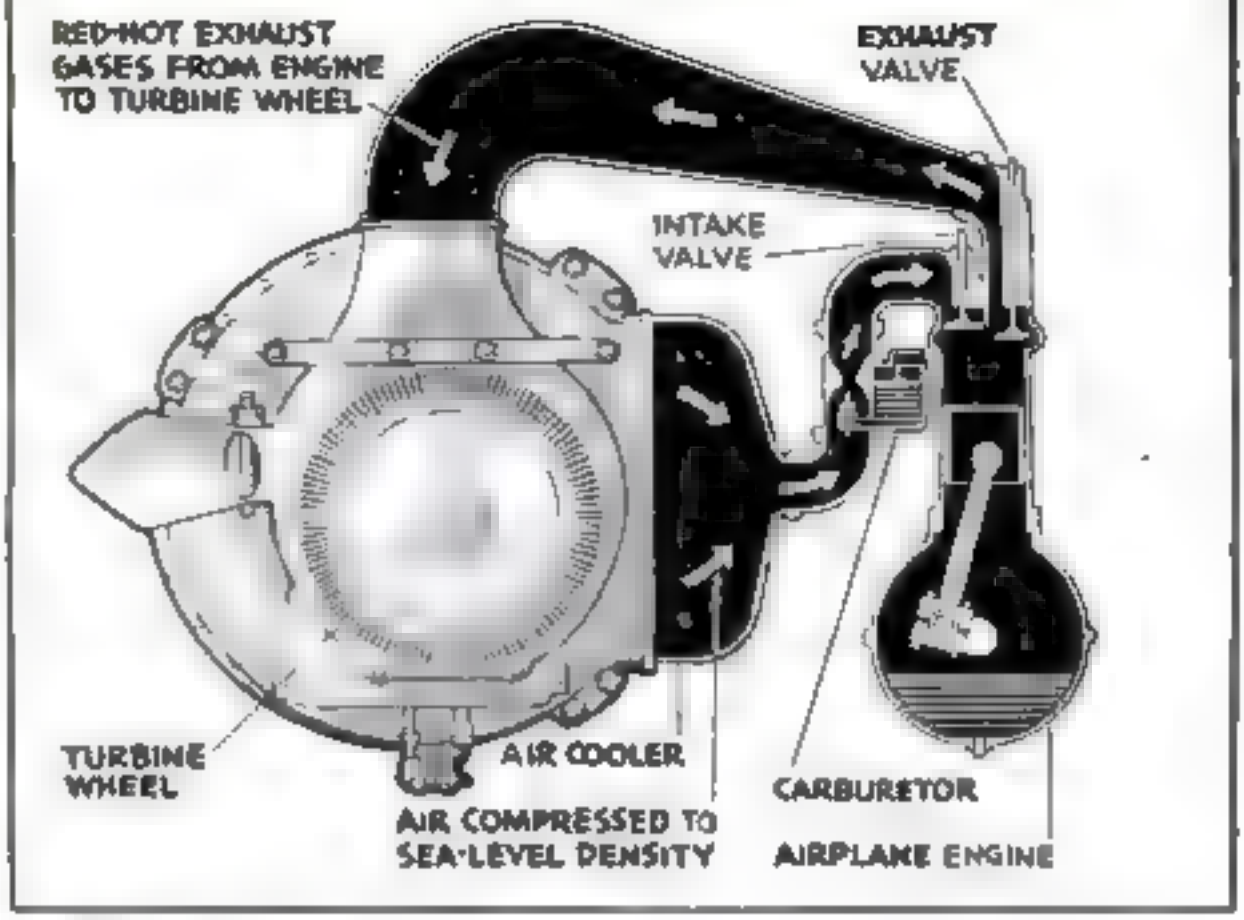
The test Liberty motor, which had produced 350 horsepower at Dayton, would give only 230 horsepower at the 14,000-foot altitude of Pike's Peak. But when Dr. Moss cut in his supercharger, it gave 356 horsepower. And this full power was much more valuable than at lower altitudes, for in the thin, high atmosphere an airplane could move at high speed with much less air resistance.

One of the great obstacles to flight had been conquered. Within two years engineers were bold enough to predict that eventually airplanes would attain the fabulous speed of 200 miles an hour! Within a few more years

Stratoliner cabins are kept at sea-level air pressure by superchargers based on Dr. Moss's work

How the turbo-supercharger harnesses flaming engine exhaust gases to feed air to the carburetor at high altitudes. It is essentially a centrifugal compressor driven by a turbine. Below, Dr. Moss examining deflector plates used in the mechanism





Igor Sikorsky was able to dream, quite sanely, of 100-ton flying boats crossing the Atlantic Ocean in less than 20 hours.

And if this country attains its ambition to produce clouds of airplanes surpassing in performance any warplanes that Europe can build, the device which probably will do more than anything else to make it possible will be this same turbo-supercharger —patiently refined and developed, down through the years, by this same elderly little scientist-mechanic, who never has been up in a military airplane, a man so gentle that he wouldn't put a sleeping dog out of his favorite easy chair.

If, for instance, the flying fortress is the superlatively great airplane that Americans believe it to be, that is in no small degree due to the fact that its four engines are equipped with turbo-superchargers, enabling it to fly vast distances at great altitude, with an unprecedented pay load.

In these days of complex industrial engineering, it is rare that any scientific accomplishment is so exclusively associated with one man as is the supercharger with Dr. Moss. When he retired at the age of 65, on January 1, 1938, after 35 years of engineering research for the General Electric Company, every modern American airplane engine (except a few small pleasure-plane motors) was equipped with a built-in geared supercharger that was patterned after designs made by Dr. Moss.

Recognized in the industry as one of the great contributors to the advance of aviation, Dr. Moss was still a disappointed man when he retired. That was because there are two kinds of superchargers, both developed by him, but the one in common use was not his darling, his great invention, the red-hot tornado of Pike's Peak.

The commercial supercharger is a small centrifugal compressor built into an airplane engine, weighing four pounds or less, which gets its power by gears from the engine crankshaft. Its gears range to a ratio as high as 14 to 1, which means that with an engine speed of 2,000 revolutions per minute, the impeller is whirling at 28,000 r.p.m. That is no mean achievement in en-

An early racing car equipped with a supercharger built by Dr. Moss. Even at sea level, the device improves vaporization of fuel and increases power

gineering. This supercharger is of value in improving the vaporizing of fuel and in increasing power on the take-off, as well as for its main purpose of maintaining power at altitude. Lindbergh made his flight across the Atlantic in 1927 without a supercharger, but since that time the device has had its part in every major accomplishment of aviation.

From 15,000 feet on up, the exhaust-driven turbo-supercharger takes over, allowing the engine to "breathe" normally up to 25,000, even 30,000 feet. But the trouble has been that few people wanted to fly above 20,000 feet. Satisfactory as it might be for the engine, it was both uncomfortable and dangerous for the aviator. Use of the turbo-supercharger had been limited to a few experimental ships and to a few squadrons of the most advanced Army planes. And though the Air Corps engineers worked eagerly with Dr. Moss to develop the turbo-supercharger, it never seemed to him that the tactical units made adequate use of its possibilities.

Important as it was, Dr. Moss's supercharger department never grew very large. It occupied one room in the General Electric research laboratories in West Lynn, Mass. For years the engineering staff numbered five men; then, as business increased, it was doubled. Airplane building simply was not a mass industry; and when Dr. Moss retired, superchargers were still a dramatic but tiny part of General Electric's vast business.

Now suddenly all that is changed. The little engineering staff has been multiplied astronomically. The company's best production experts have been moved in. Great factories are being rushed into commission for mass production of impellers and turbines for superchargers. Millions upon millions of dollars are being poured in.

And back on the job in the midst of it all is Dr. Moss himself, called back to work as consulting engineer—as happy, dazed, and excited as two children at the circus. At 68 years of age, his dreams have come true.

The story of the turbo-supercharger is the story of Dr. Moss's life, for the device is the perfect and ultimate expression of his whole scientific career. When he was 16 years old he was apprenticed as a mechanic in San Francisco, in a shop which made air compressors of the reciprocating type; and right then began a lifetime of specialization in the compression of gases and the flow of gaseous fluids. After finishing his four-year apprenticeship, young Moss boned up for entrance examinations and started as an engineering student at the University of California, sweeping up the floor of the college shops to earn his way. By 1900 he had taken his bachelor's and master's degrees, and then went on to Cornell University as an instructor and advanced student. In 1903 he received his degree as a Doctor of Philosophy.

All of Dr. Moss's research work as a graduate student had been on a project for a gas turbine, which so interested General Electric that he was taken on as a company engineer to continue the work. This turbine was to be a primary source of power, combining principles of the internal-combustion engine and the steam turbine. One part of this mechanism was a centrifugal compressor, on which patents were first taken out in 1904. As time went on this compressor became an important item of company business, manufactured for iron foundries, blast furnaces, pneumatic tubes, oil burners, and other purposes.

But the gas turbine itself had to be postponed. Regretfully it was put away on the shelf. In a scientific sense no experiment is a failure if it contributes to human knowledge, but it must have been a terrific disappointment to a practical inventor like Moss to put aside his great life project.

So matters rested at the time of the first World War. In fighting planes, altitude is one of the greatest advantages, and the idea for a supercharger occurred in various places at once. The British tried to develop a geared compressor. The French scientist Rateau had the idea of driving a super-

In this LePere biplane, equipped with a Moss G. E. supercharger, Lieut. J. A. Macready made a record altitude flight to 40,800 feet September 28, 1921

The turbo-supercharger installed at the side of the Liberty motor on an early OH-4 plane. Pilots were dubious at first about flying "with a red-hot stove"

charger with exhaust gases. The idea was all right, but the superchargers wouldn't work.

After the United States entered the war, the National Advisory Committee for Aeronautics took up this problem, and knowing of Dr. Moss's work, turned the job over to him. It was right down his alley. His centrifugal compressor was just the thing. As for power, down off the shelf came the abandoned gas turbine. Within a few months the two had been hitched up, in the tame tornado of the Pike's Peak test.

Except for refinements that have been made through the years, that first supercharger was the turbo-supercharger of today. Its idea was simplicity itself. The compressor sent air into the intake manifold at sea-level pressure. The gases in the exhaust manifold were also at sea-level pressure, and were directed through nozzles on the buckets of the revolving turbine.

Technical discussions of the turbo-supercharger are discouraged in these days of military secrecy; but the difficulties are easily apparent to anybody who has ever had trouble with an overheated bearing. The exhaust fumes are at 1,500 degrees F. Manifolds and buckets are red hot, while the turbine revolves at 20,000 or more revolutions a minute. And on the same drive shaft, only a few inches away, the compressor is handling atmosphere which has been recorded as low as 76 degrees below zero! The turbine emits a four-foot tongue of flame, which at high altitudes freezes instantaneously, and on occasion has settled as ice on the wings of the airplane itself.

A turbine bucket is a little fin like a blade on a windmill. In the Moss turbine the buckets are a fringe of little blades, of a secret heat-resistant steel, mortised into the rim of the turbine wheel. Tested at 22,000 revolutions a minute, a turbine bucket is traveling 1,000 feet per second, in a circle less than 12 inches in diameter. Weighing less than 1/100 of a pound, a little red-hot bucket at this speed is subjected to a centrifugal pull of about 1,750 pounds.

Moss's first turbo-supercharger was light enough for one man to carry. It was figured that a commercial compressor delivering the same amount of air would weigh 5,000 pounds and occupy a space of more than eight cubic yards.

Experimental work with the supercharger was interrupted by the Armistice of 1918. The time was yet to come when it would be tested in an airplane. Pilots looked at it dubiously. One of them described it as a combination cook stove, blacksmith forge, and flying junk shop. An airplane engine itself is a sufficiently terrifying bit of leashed power. A red-hot turbine, revolving at 20,000 r.p.m., was hardly a comfortable companion in the crates which aviators flew in those days.

On September 27, 1920, Major R. W. Schroeder took off in a biplane fitted with Dr. Moss's turbo-supercharger. At 25,000 feet he encountered a head wind so strong that he drifted backward. But he went on, up and up, until his instruments recorded 33,000 feet. At this altitude his goggles frosted over. As he struggled with them his oxygen supply gave out. Unconscious, he dived for nearly six miles.

Schroeder never did understand how he got that plane back on the ground. Half recovering his consciousness at a few thousand feet altitude, he managed to right the plane. He could hardly open his eyes. But somehow he managed to land safely.

As Dr. Moss improved the supercharger, altitude records were broken again and again, establishing the pioneering fame of the Army aviators Macready, Stevens, Street. But the difficulties encountered by Schroeder have never been really conquered. Only recently the Mayo Clinic, after researches on the subject, announced that a man deprived of oxygen at 35,000 feet would die almost instantly. Even with an oxygen mask, at that altitude and low pressure, a man does not function normally. Army flyers in pursuit ships are under orders to use their oxygen tubes when above 10,000 feet.

In the years just preceding the present war, there were encouraging experiments with planes built with sealed cabins, within which warm air was kept at pressure. But such cabins are not puncture proof and will be less useful in war than in peace. Provision of adequate oxygen for high flyers is one of the major problems of the present war.

Miraculous as the advance of aviation has been, the slow development of stratosphere flying has of course been discouraging to Dr. Moss. That it has developed at all has been due largely to an irrepressible, impish quality of the inventor, who for 20 years encountered what he called the "glassy eye" of industrial executives and Army brasshats, and would not accept discouragement.

At the time of his retirement an anonymous writer in "Mechanical Engineering," who must have known him very well, described him thus:

"Painstaking, nervous, his eyes sparkling with fun or fury, Dr. Moss raises his pointed beard in his companion's face and looks at him through the lower lenses of his glasses. His tongue, trying to keep up with an agile mind, is ready for a persistent barrage of embarrassing questions or a volley of explanations. He possesses that disarming characteristic of small boys with whom it is

impossible to be angry for long in spite of sometimes exasperating behavior. Once you have met him you never forget him, but think of him in terms of warm affection."

Back in the days when General Billy Mitchell was unsuccessfully fighting the inertia of Army commanders, Dr. Moss was carrying on his own private war against the same thing. They couldn't get rid of him, yet they couldn't get mad.

He is a man of many engaging idiosyncrasies, and his friends have an apparently inexhaustible supply of anecdotes about him. He always carries a pocketful of quarters, and engages every one possible in a coin-matching contest, explaining that this is not gambling because the laws of probability will certainly bring him out even at the end of the year. While enjoying a short vacation at a summer camp with some of his associates from General Electric, he was voted the "best sport." That was after he had been assigned, as his share of camp work, to be valet to a team of mules. He turned up for work equipped with an ash can, a freshly laundered white-wing suit, and a high silk hat.

He has a habit of asking young men what their pleasures were as children, and out of such researches has evolved an aptitude test which General Electric uses in its personnel work. His theory is that education should be concentrated only along the lines of the pupil's aptitudes. "A young fellow who never took a clock apart can never become a mechanical engineer," he says. He doesn't care whether the clock was ever put together again. What counts is the curiosity —the desire to know how things work.

Once Dr. Moss argued unsuccessfully before a police-court judge, with elaborate mathematical formulas, that a speed cop could not possibly have clocked him accurately, because the cop had to go faster than he, to overtake him. More successfully he once defied a traffic cop who told him to pull over to the side of the road. "I won't do it!" he exclaimed. "The law says I can't drive without my license, and you've got it!"

On occasion, to get some place in a hurry, Dr. Moss reluctantly has flown in a commercial airplane; but he has never been on an experimental flight. "It would contribute nothing to the development of the turbo-supercharger, so I just don't do it," he explains. Once his associates at Wright Field ganged up on him, insisted that he must go up with them for consultation. He put it off to next day, and in the morning a telegram arrived from General Electric, expressly forbidding Dr. Moss to make the flight. Triumphantly he obeyed.

This reluctance seems to have nothing to do with courage. No one but a brave man would fool around with experimental turbines. During the test of the supercharger at Pike's Peak, his associates had to tie him to a post with a piece of rope, while he worked on the engine, to keep him from absent-mindedly backing into the whirling propeller.

In all his triumph, Dr. Moss is still able to find good-natured cause for complaint.

"First they told me it couldn't be done," he says. "Then they said, 'What's the good of it?' And now what do they say? They say, 'We were going to do it all the time.'"

Now that the turbo-supercharger is really being developed, Dr. Moss is bursting with ideas of how it could be used for peacetime purposes. But he still encounters the "glassy eye." Nobody will listen. All they think about is providing the stuff to win a war.

Back in the old days he could complain, argue, make propaganda, fight for his ideas. But this time he is stumped. The turbo-supercharger is now so important that they won't let him say a word about its present or its future.

Even his dreams are military secrets.

Uncle Sam's flying fortresses owe their ability to fly high, fast, and far, to the fact that their engines have turbo-superchargers

"Onion Throwers"
Blast Dive Bombers

A NEW defense awaits dive bombers tackling Great Britain's new battleship *King George V.* Pictures taken when the 35,000-ton vessel visited the United States recently revealed four weapons the like of which have not been seen before in any navy. Nicknamed "onion throwers" by some observers, their purpose is to throw such a quantity of high explosives in the path of a plane that if it is not destroyed, at least it will be unable to aim its bomb effectively. A. G. Cole, writing in "Our Navy" magazine, states that each weapon has twenty barrels, each at least 7.5 inches in diameter and about eight feet long. He suggested that the nearest comparable weapon was the 7.5-inch howitzer developed during the last war which fired a 100-pound high-explosive shell for a distance of 2,100 yards from a single barrel.

Four novel antiaircraft weapons guard H.M.S. *King George V.* Each gun has 20 barrels of at least 7.5-inch diameter and eight feet long

Photos New York Daily News

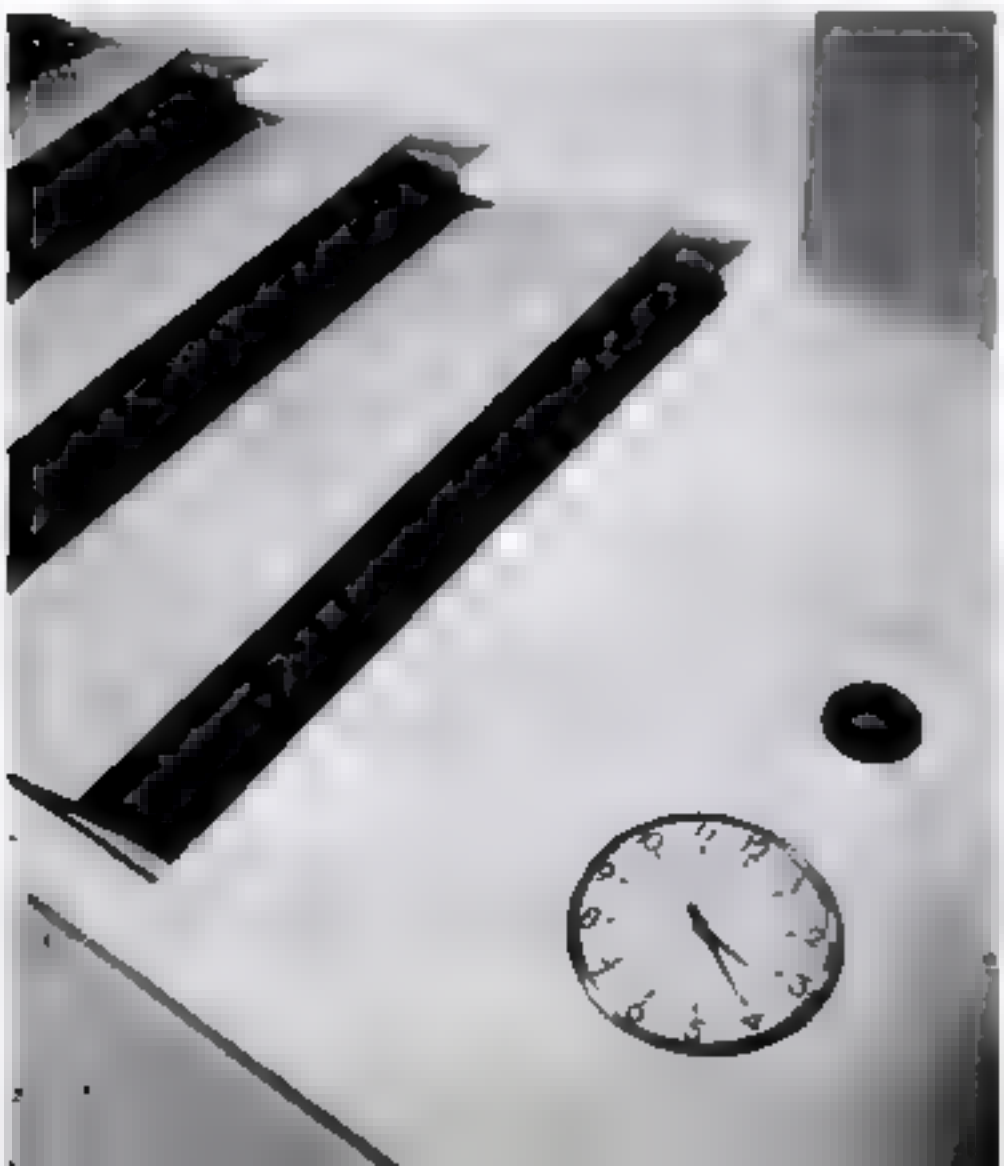
A scene in the Columbia Broadcasting System s new studio in New York City, showing the novel "acoustivanes" in the background

RADIO STUDIO HAS

ADJUSTABLE WALLS

TO GIVE radio sound engineers better control over studio acoustics, movable, resonant panels have been installed along the walls of the Columbia Broadcasting System's new studios in New York City. The "acoustivanes" in each studio are electrically controlled so they can be adjusted to various positions during a program. The panels are hardwood on one side and a sound-absorbing wood on the other. Most of them are 14 feet high, 29 inches wide, and five inches thick at the center.

Resembling huge vertical Venetion blinds, these movable resonant panels are adjusted by electrical control. One side of each panel is of dense wood, the other of soft, porous wood that absorbs sound



America Listens In

Day-by-Day Recordings of Europe's Radio Programs Reveal the Tricks of Germany's War Propagandists

By EDWIN TEALE

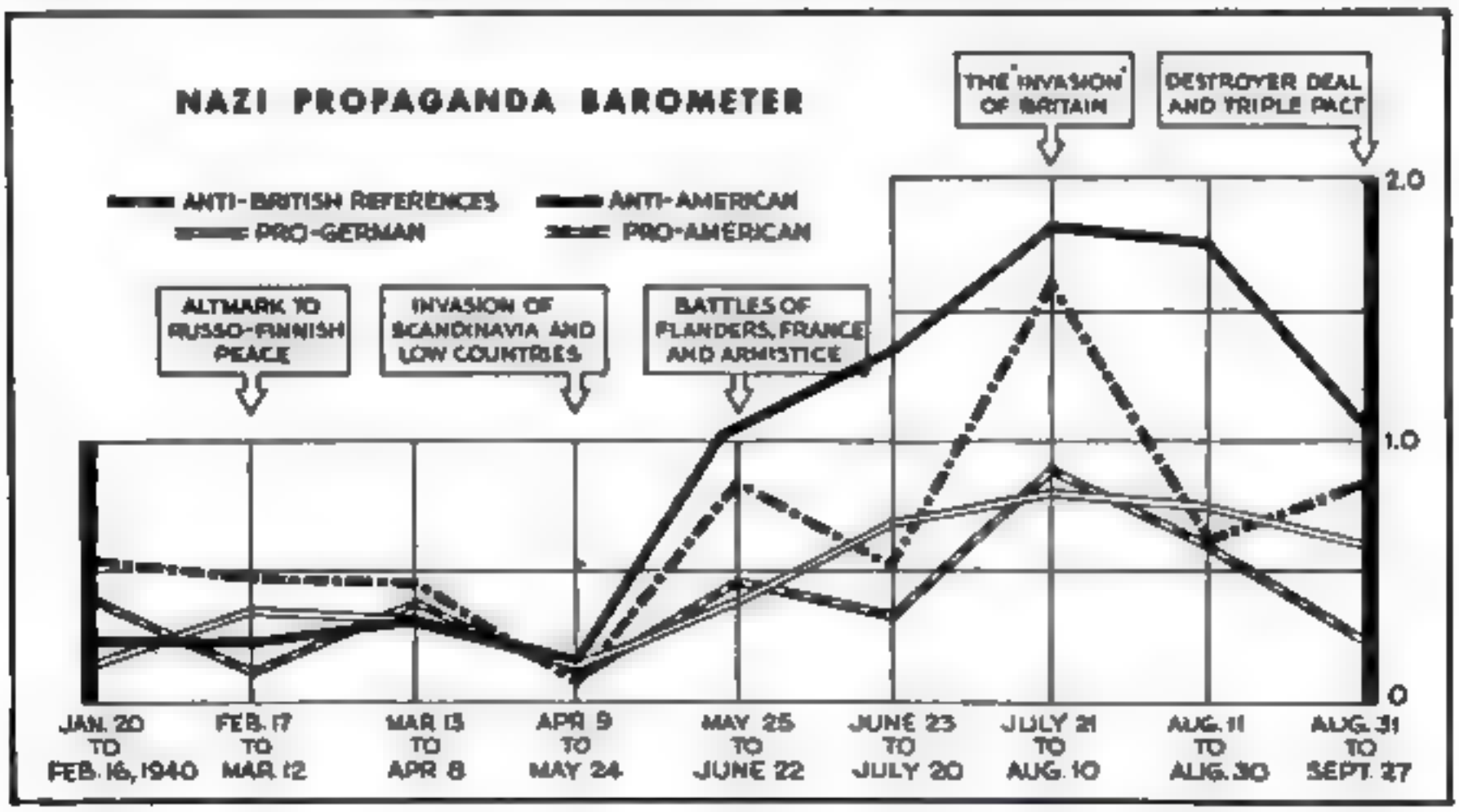
IN A white frame building on a side street in Princeton, N. J., 6,000,000 words of radio propaganda have been recorded on wax cylinders, translated, transcribed, coded, and filed for study. Here, day after day, America listens in. Under the direction of Harold N. Graves, Jr., and financed by the Rockefeller Foundation, the Princeton Listening Center has been active since November 27, 1939. It represents America's first serious attempt to analyze propaganda on the air waves. Similar listening posts are now being established in various parts of the country by the Federal Communications Commission and the Defense Communications Board, though their methods of operation will be different in some respects.

From midafternoon until almost midnight, each day, J. R. Snedeker, the Center's radio technician, is busy with two short-wave receivers wired directly to electric recording machines. Earphones on one receiver, and a loudspeaker on the other, enable him to start recording as each propaganda speech begins.

Nearly 9,000 wax cylinders, representing some 100,000 minutes of speaking, have gone through the Princeton recording machines in the past year and a half. Sometimes the translators find as many as 40, each with its identifying slip, waiting for them when they come to work in the morning. Once, Snedeker was 95 records ahead of the translating staff. But the score was more than evened up last year when sun spots disrupted short-wave communication for weeks on end.

With earphones clamped to their heads, the four translators type out the speeches in English. On each typed sheet, in the right-hand margin, a coding expert jots down symbols to indicate the propaganda theme used by the speakers. Such symbols enable later research workers to trace the develop-

How German propaganda follows or even forecasts events. Vertical scale represents references per day



ment of any given theme with a minimum of effort. After coding, the sheets are bound, according to language and broadcasting station, and filed in a research room upstairs. At present, Graves is specializing in British propaganda, Philip Jacob in German, and Bruno Foa in Italian. By means of reports, graphs, and summaries, they are reducing the propaganda of the belligerent nations to its basic, simple elements.

Germany, in its short-wave bombardment of England and America, makes use of half a dozen distinctive types of propaganda. The Princeton Listening Center has pigeonholed them as the propaganda of terrorism, of paralysis, of dissension, of confusion, of variety, and of division. The different types rise and fall with the shift of events.

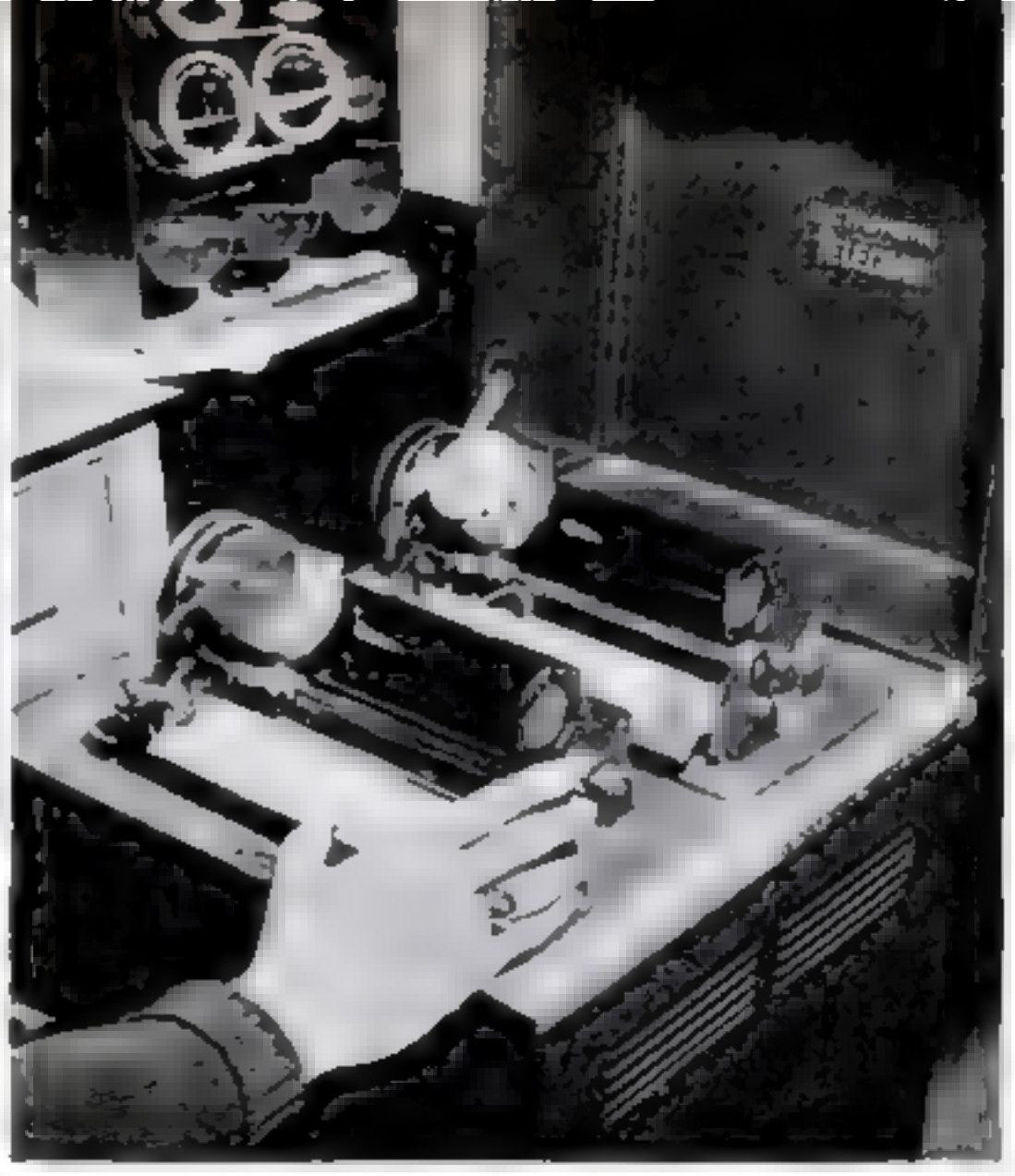
Terrorism propaganda always reaches a peak just before a brutal, all-out attack from the air. It is the simplest and least subtle of the weapons used in a war of nerves. The devastation of Warsaw; the destruction of Rotterdam; the terrors that lie ahead for the women and children of enemy cities, are stressed again and again. Recently, to increase the depressing effect of British losses at sea, German broadcasting stations have preceded the announcement of each torpedoed ship with the doleful tolling of a bell.

Propaganda, as such, rarely changes the natural course of events. But it does accelerate or slow it down. So, in the early months of the war, Germany concentrated on the propaganda of paralysis during broadcasts to the United States. In an effort to slow down the natural drift toward aiding England, it tried to discredit the press and to make people suspicious of what was printed and what was released by public officials. It emphasized defeatism and the certainty of Britain's fall. It praised statements opposing foreign entanglements and lauded America's decision to keep its ships out of European waters. Before each invasion of a neutral country, when Americans might be tempted to rush into action, the tempo of this kind of propaganda was accelerated.

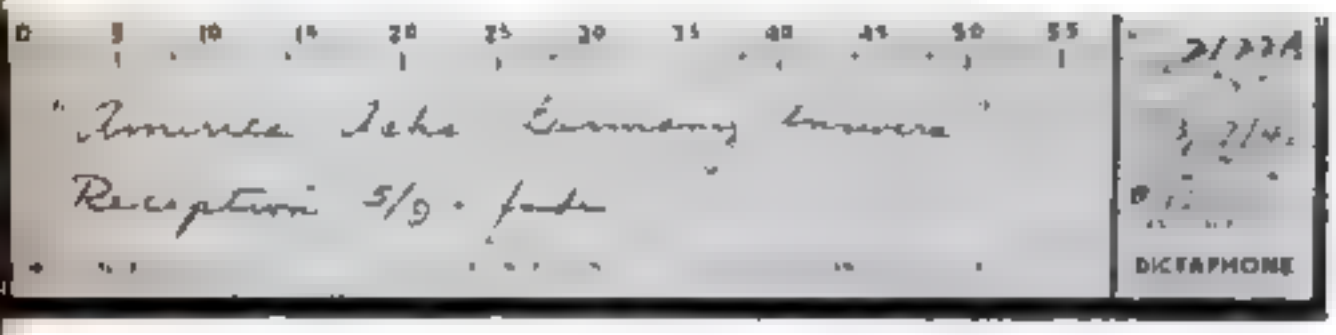
At the same time, an attempt to drive a wedge between Britain and the United States by the propaganda of division zoomed just before each major move of the German Army. Berlin broadcasters played up such things as the seizure of American mail by the British and previous differences between the two nations. They even trotted out the ancient grudges of the Revolution and the War of 1812 in an effort to alienate the two countries.

Ill feeling of another kind is the aim of the propaganda of dissension. By recalling dissatisfactions, grievances and class hatreds within the United States itself, it seeks to produce internal quarrels. By distorting

Harold N. Graves, Jr., executive director of the Princeton Listening Center, with J. R. Snedeker, radio technician (seated), at the two short-wave receiving sets used in recording the broadcasts



At the right is one of the two electric recording machines wired to the receiving sets. Wax cylinders used during a night's reception are placed in racks like the one shown above, each identified by a slip filled out by the operator. One of these slips is reproduced below



news items, it calls attention to the differences of labor and capital, of Jews and Christians, of negroes and whites. The goal of this type of short-wave propaganda is to produce continual friction and prevent the nation from becoming an efficient, smooth-running machine.

At the time of the fifth-column scare in this country, still another type of German propaganda came to the fore. In rapid succession, the Berlin commentators broadcast varying accounts of the fifth column. First, they maintained it was all sheer imagination. Then they veered quickly to the idea that it was something concocted by the British. And, as quickly, they took a new tack. It was, they said, merely a bogeyman thought up by the Administration to distract attention from its failures. By pointing in several directions at once, the propaganda of confusion seeks to bewilder those who might feel impelled to act.

Finally, there is the propaganda of variety. For each aggressive move Germany has made, the short-wave radio has carried innumerable reasons, explanations and arguments. By giving a wide variety of arguments, the propagandist tries to suit everyone. If one of his explanations seems phony, another may carry conviction. So he uses a verbal shotgun instead of a rifle in his attempts to present events in the most favorable light.

Close study of these different types of propaganda has enabled the Princeton listeners, on a number of occasions, to obtain an inkling of com-

Isotta Mesoni, one of the four translators, at work. Foreign-language speeches are translated and typed out in English

ing events. The propaganda of division, for example, rose to a peak last spring as the German soldiers overran Belgium, Holland, and France. Later in the summer, it began to subside and the Princeton experts concluded that the threatened invasion of England had been postponed. By noting a sudden jump in frightfulness broadcasts, they also were able to predict, within a few days, the major air offensive against London. Different types of propaganda, they have found, precede all-out attacks by air and by sea. The former stresses frightfulness and the terrors of a threatened blitzkrieg from the sky; the latter features the suffering in countries blockaded by Britain, in order to justify ruthless attacks on shipping by submarines and aircraft.

Today, as many as 500 propaganda programs a week are aimed at the 20,000,000 receiving sets in the United States capable of picking up short-wave broadcasts. To cope with this rising tide, the Princeton Listening Center has had to boost its staff from four to ten. The work of this group represents national preparedness of a new kind. It is preparedness on the so-called "fourth front" of the war, the front of propaganda.

THE SIX KINDS OF AXIS PROPAGANDA

1 **PROPAGANDA OF TERRORISM.** Its aim is to break down the morale of the public in enemy countries by threats and "frightfulness" broadcasts.

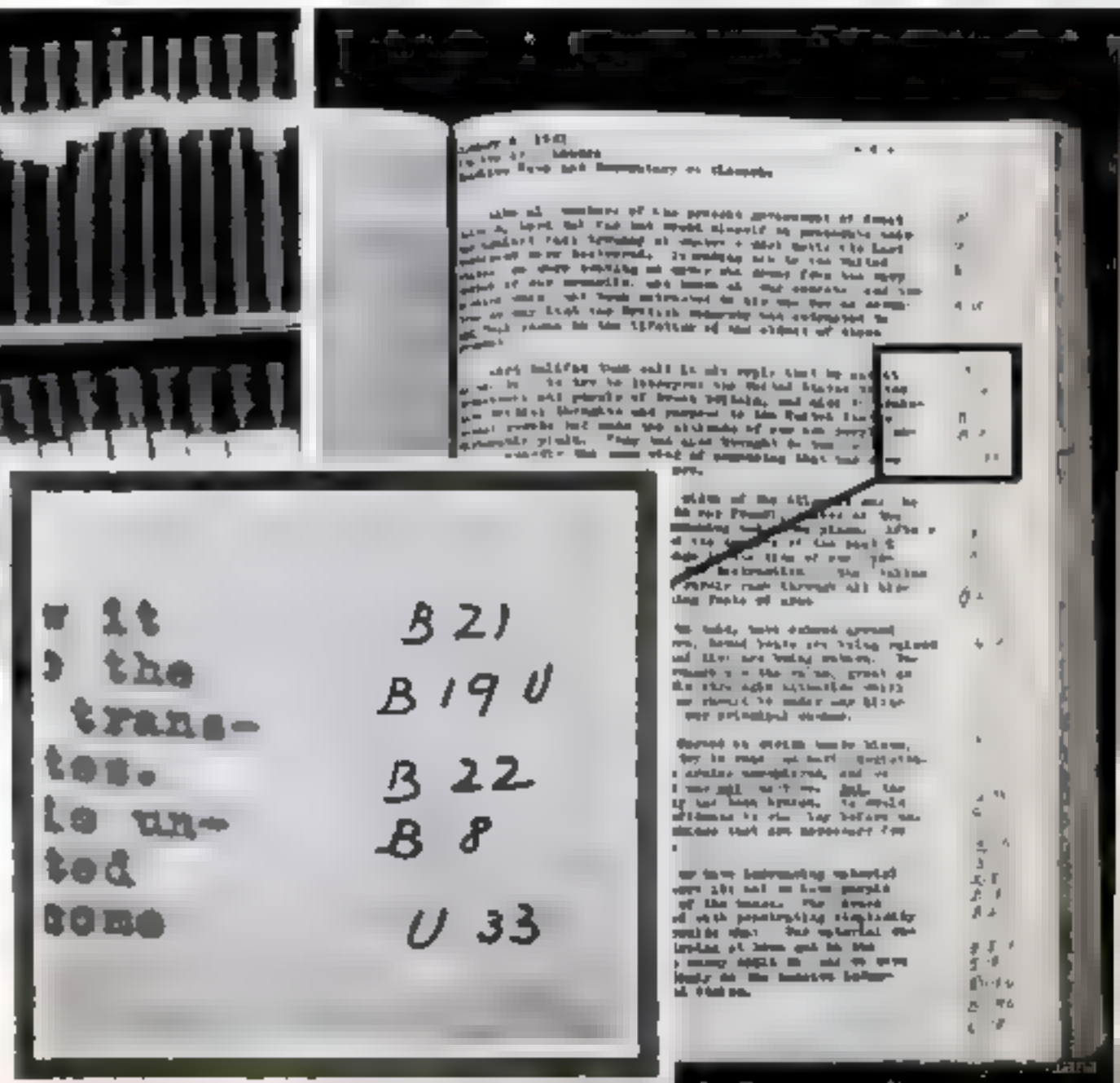
2 **PROPAGANDA OF PARALYSIS.** Its goal is to keep America inactive by dividing sentiment and preventing the people from reaching a united decision.

3 **PROPAGANDA OF DIVISION.** It tries to drive a wedge between Britain and America by emphasizing frictions and divisions of the past.

4 **PROPAGANDA OF DISSENSION.** Its aim is to cause ill feeling in the United States by arraying class against class, creed against creed, race against race.

5 **PROPAGANDA OF CONFUSION.** It attempts to prevent prompt action by public officials by bewildering them with various hints pointing in different directions.

6 **PROPAGANDA OF VARIETY.** By giving a large number of arguments and excuses for Nazi actions, it seeks to convince everyone. Those who reject one explanation may accept another.



Typed speeches are bound and filed by language and station. Code symbols in margins show appearance of various propaganda themes. B 8, for example stands for "British war aims"

A pursuit plane at Fort Lewis, Wash., simulates an attack on an old blimp made into a barrage balloon

Army's Balloon-Barrage Squadron

CAPTIVE BALLOONS are being used increasingly by the U. S. Army. At Fort Lewis, Wash., soldiers of the 3rd Barrage Balloon Squadron have been undergoing training for some time in the technique of handling gas bags which could be used in wartime for spotting enemy positions, directing artillery fire, warning of approaching enemy planes, and as obstacles to attack on important areas. Because no proper balloons were available when the training program began, a blimp, with the gondola removed and a basket hung in its place below the envelope, was used to give the troops practice in raising and lowering balloons. For use as protection against air attack, long steel cables could be hung from the bags in place of the basket.

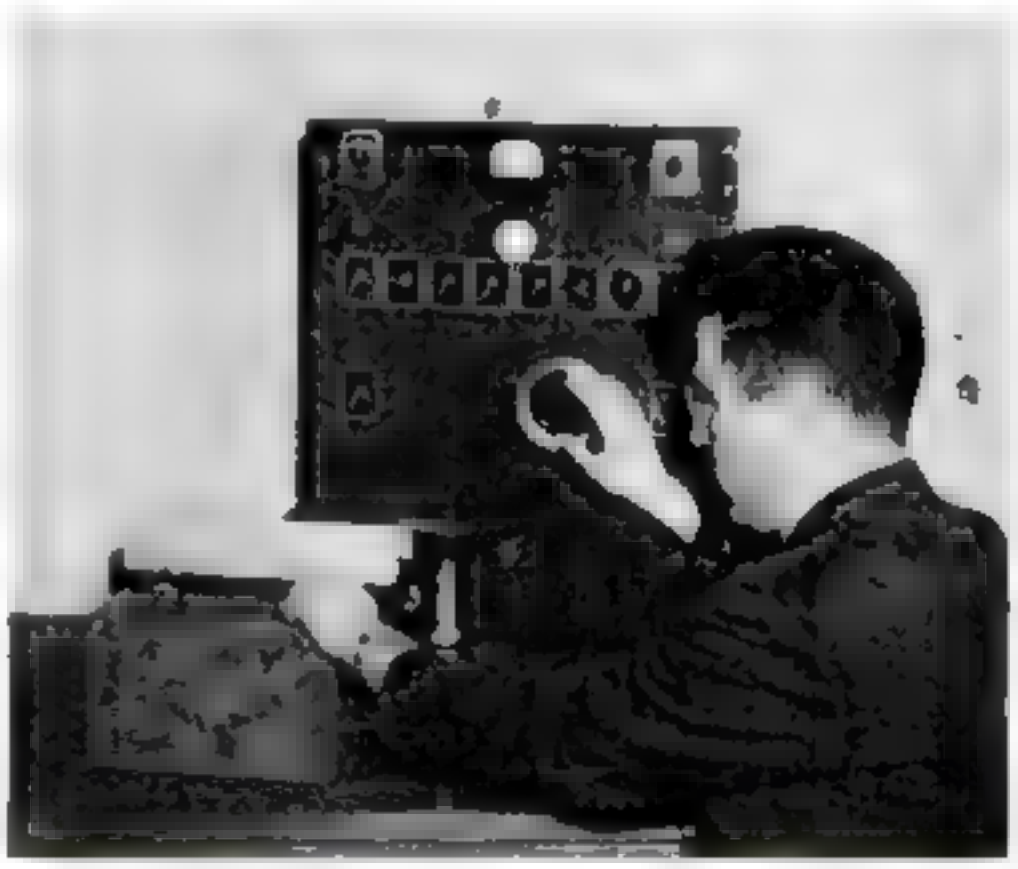
Blackboard instruction on how to place balloons around a city for an air barrage

America Makes Her Own Cigarette Paper from Home-Grown Flax

Pick-up baler collecting flax straw on a Minnesota farm. "Ready-sliced" bales, as at right, yield fiber for cigarette paper

CIGARETTE PAPER from American flax straw, perfected after seven years of research, comes just in time to replace supplies cut off by the war. Formerly, all the $10,000,000 worth of cigarette paper used here annually was imported from Belgian and French mills, where it was manufactured from linen rags. Today, four North Carolina mills turn out paper of the required thinness and strength, using the home-grown material. Large acreages of flax straw in Minnesota are harvested by the combine method with the aid of a new pick-up baler, half as heavy as standard types and twice as fast. The bales, "ready-sliced" like bread, go to near-by processing plants, where the straw yields raw flax fiber for shipment to the mills.

Highway Materials Tested by Electrical Oscillations



QUICK and accurate testing of road-building and other materials is said to be possible with an electrical device developed at Kansas State College. A sample of concrete, subjected to repeated freezing and thawing, is placed on supports as shown at right. Oscillations are then induced in it until its natural vibrating frequency is found. This is a measure of its strength. Brick, stone, and steel may also be tested. The device employs an audio-frequency oscillator, crystal pick-up, cathode-ray tube, and vacuum-tube voltmeter.

"Calling CQ" Relates Tales of Radio Hams

PROBABLY no one will ever know how many lives have been saved, or how much suffering has been averted, by the efforts of the "hams," or amateur radio operators. Or how much pleasure the hams have derived from their hobby. But in "Calling CQ," (Doubleday, Doran & Co., $2) Clinton B. DeSoto has rounded up some of the high spots in the history of these wanderers of the ether waves. The stories in this 291-page book range from accounts of amusing "rag-chewing" incidents to tales of heroic acts that have won national acclaim for the men who performed them. The author knows his subject, as he is a member of the staff of "QST," the magazine of the American Radio Relay League, and is an active ham himself.

Everything on Earth in Book for Children

SCIENTIFIC facts about the earth and the universe are the subject of Gertrude Gouvy's "Speaking of Earth," (Bruce Humphries, Inc., $1). Written primarily for youngsters eight to 14 years of age, the story of how the earth came into being and arrived in its present position with relation to the sun, moon, stars, and planets is clearly and simply told in this 64-page book. Legends and beliefs of earlier civilizations about our solar system, some of which still seem strangely logical, are added to lend life and humor to the story. For children who like their science presented in pictures as well as text, Miss Gouvy has drawn 53 cartoon-like illustrations which will aid the most unscientific-minded of youthful readers to understand the fascinating story.

Eli Whitney, Father of Mass Production

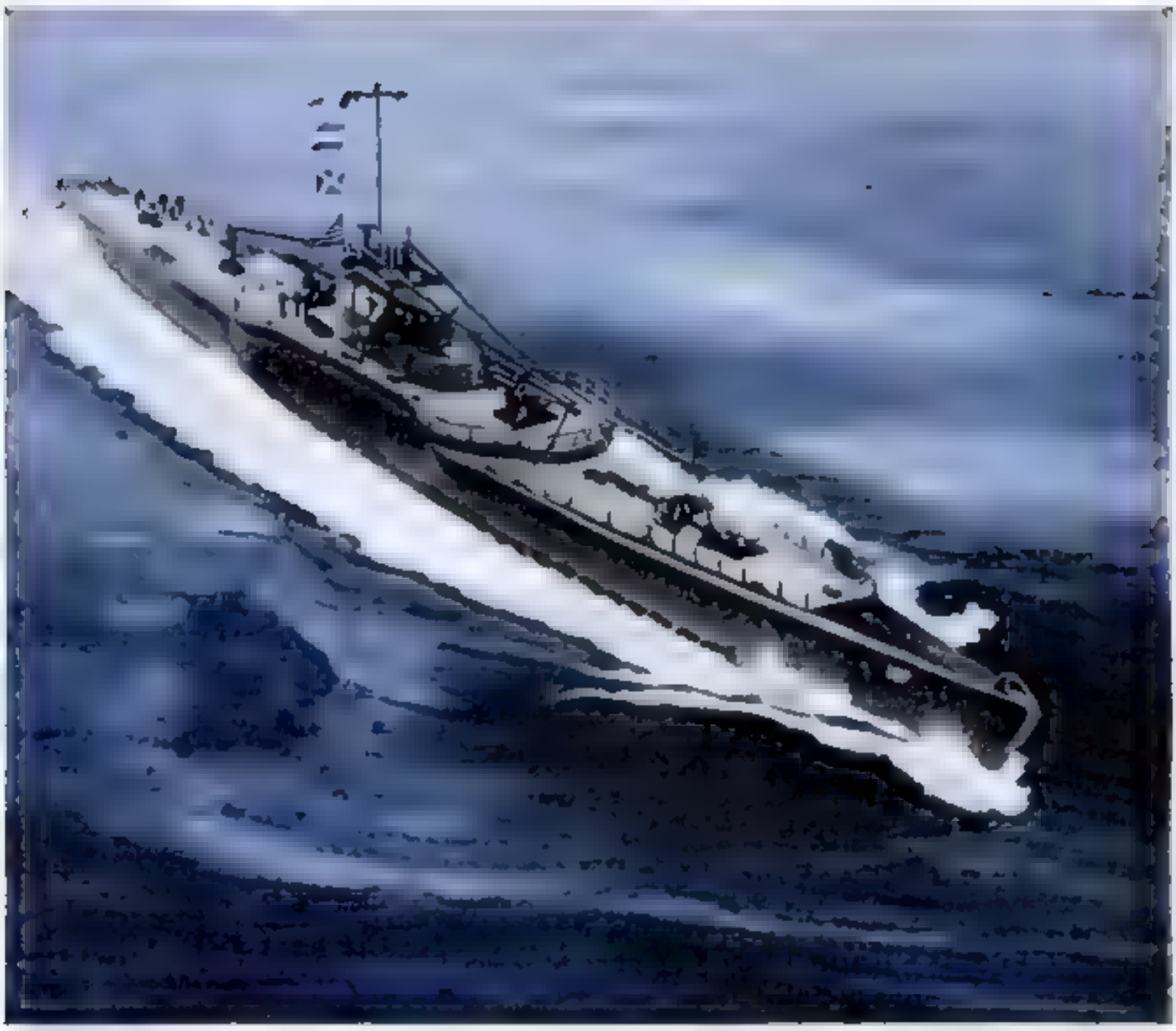
THOUSANDS of school children can tell you that Eli Whitney invented the cotton gin. But not many of them can tell you that he developed and introduced to America the manufacturing processes which we now know as "mass production," and which have made the United States the greatest industrial nation on the face of the globe today.

The story of Whitney's life, told in Roger Burlingame's "Whittling Boy," (Harcourt, Brace & Co., $3, 370 pages) is the truly American saga of a man with a vision and the courage to pursue it in the face of derision and disbelief. The cotton gin played an important part in the story, but it was only a step toward the development of greater things.

Even as a youngster on his father's Massachusetts farm, Whitney preferred tinkering with mechanical things to farming. He was forever turning out devices to simplify the housework or the farm work.

Probably the most important event in Whitney's life, both to him and to the United States, occurred in 1798, when he took a Government contract to manufacture rifles. The guns were needed in quantity, and in a hurry. So Whitney made machine tools which turned out the guns so accurately that, for the first time, the parts of one gun were interchangeable with those of another, and even the most unskilled apprentice could operate the machines. To Whitney, they were only a sample of the machines that would be made some day to make other machines for the progress of civilization.

If your bookseller cannot supply the book you want, order from Book Department, POPULAR SCIENCE MONTHLY, *353 Fourth Avenue, New York.*



Paintings by Matt Murphey, U.S.N.

One of the world's largest submarines, the U.S.S. Narwhal carries two 6-inch guns, six torpedo tubes

Submarines in War

By YATES STIRLING, Jr.,
Rear Admiral, U.S.N., Retired

JUST what is a submarine? It is a warship designed for traveling under water and attacking its enemy unobserved with torpedoes. Its ability to surprise is the submarine's most important attribute.

A surface warship, when overtaken or encountered by an enemy, must stand and fight, unless it has sufficient speed to run away. A submarine need not fight, nor need it show its heels to an enemy ship. All it need do is submerge, and the surface enemy is baffled.

The value of the submarine has not changed markedly since World War I. It has been improved, of course. Engines are more reliable and noiseless, better and greater-capacity storage batteries are installed, more rugged motors are fitted. Torpedoes have been improved in accuracy, and run with greater precision. More scientific methods of submerging have been achieved and the many instruments and devices used in underwater navigation have become more accurate and reliable. Underwater listening devices in submarines have been developed to such an extent that submarines now can fire their torpedoes using direction finders on the listening-device principle without showing their periscopes.

Submarines today are even more of a menace to shipping than they were in World War I. This is due, almost entirely, to the relatively fewer antisubmarine vessels available to combat them. The security of the

commerce of any nation fighting another with a large submarine fleet is almost in direct proportion to the number of anti-submarine vessels that can be pressed into service. Convoys must funnel into known ports, and therefore submarines can strike at them with a minimum of cruising. These submarines need only take up their stations where the trade routes converge. The convoy system is none too simple to work out successfully. Merchant ships are of different speeds, and the speed of a convoy is that of the slowest vessel. Faster ships have been placed in convoys by themselves, but this increases the number of convoys being used, and many more warships for escort are needed. The inexperience of merchant-marine personnel in maneuvering their ships in close formation is another difficulty. The lack of experience in handling ships causes a spread of vessels in convoy, permitting a submarine to attack stragglers that are left without proper escort. This fault increases enormously the arduous duties of destroyers.

The submarine's most important function is to intercept a warship or merchant ship, using first stealth and then invisibility to arrive at a position from which to torpedo the target vessel. That seems simple enough to state, but its accomplishment is not so easy, nor is it entirely without risk to the submarine.

The merchant ship or warship may be a part of a convoy of many vessels. There may be a number of antisubmarine vessels present with the convoy, the most effective for the purpose being the very fast destroyer. The submarine is under water and therefore invisible. When it has arrived at a position from which its torpedoes can hardly miss, it fires its missiles. At this moment, it reveals its presence to all the vessels of the convoy, and then its troubles begin.

In the bow of the submarine, and sometimes also in its stern, are torpedo tubes. When a torpedo is fired from any of these tubes, with either a powder charge or compressed air, there is created a large bubble of gas or air on the surface of the sea above the submarine. If an antisubmarine vessel, say a destroyer, is alert, that bubble gives information just where the submerged vessel is located. Then the destroyer charges down to the spot and lays a depth-charge barrage all about the position of the hidden submarine.

The torpedo or torpedoes—oftentimes two or even more are fired simultaneously at a particularly valuable target—are then on their way towards the victim. They leave a white wake behind them, caused by the air bubbles from the exhaust of their speeding turbines. These wakes can be seen by the attacked vessel and by the destroyers in the escort, and depending upon the distance from which the submarine has fired its shots, the attacked ship has an opportunity to maneuver to avoid the torpedoes.

The submarine, after discharging its death-dealing missiles, has an important defensive role to play to save itself from destruction. This is to avoid the depth-

A "mother ship" and her brood. From left to right: U.S. Submarines *Pollack*, *Plunger*, *Pickerel*, *Narwhal*, *Perch*, *Permit*, *Tarpon*, and *Shark*, with submarine tender *Holland*

charge barrage certain to be laid about it.

When the torpedoes were fired, the submarine was at periscope depth—a depth under water from which it could raise the telescoping eyepiece of the periscope above water to observe its target. The first thing for the submarine to do then is to dive as quickly as possible. From a depth of about 35 feet, it uses its horizontal rudders to carry it to as great a depth as its hull will permit, which is not far from 200 feet, and at once changes its course radically, while increasing its underwater speed. This will carry the submarine out of the danger zone as rapidly as possible

A depth charge must explode fairly close to a submarine in order to wreck it, so a submarine attacked by a destroyer still has a good chance of escape. Destroyers carry from 40 to 50 depth charges, and they are most generous with them. Depth charges are usually set for detonating at about 100 feet. The depth-charge explosion is a point and the force of the explosion is mostly upwards. Thus a cone of pressure is formed, its size depending upon the depth at which the charge explodes. If any part of the submarine is within this cone of pressure, the effect on the submarine is serious, causing extreme pressure on every part of the hull, and consequent leaks. If the hull of the submarine is outside the zone of pressure the effect is less. But even then, the shock of the explosion will cause the submarine to be badly shaken up, putting out lights and leaving the personnel in darkness, causing circuit breakers to blow, and in general disturbing the morale of the crew. Depth charges ex-

ploding as far as 200 feet away have been known to cause the personnel of a submarine to lose their nerve, blow ballast tanks, and bring their vessel to the surface, to be sunk by gunfire or captured.

While on the surface a submarine is propelled by Diesel engines. On the propeller shafts are large electric motors, used for power in underwater navigation. Large storage batteries supply the power to the motors. These motors can be driven by the engines as generators to recharge the storage batteries. This recharging can be accomplished only while the submarine is on the surface. Recharging of batteries can be done also when running on engines on the surface by what is known as "floating the batteries on the line."

THE engines give the submarine a surface speed of 13 to 20 knots, depending upon the type of submarine. The large fleet submarines are given a higher speed of about 20 knots in order that they can accompany the battleships. The high underwater speed on battery and motors is seldom over ten knots.

A submarine's battery capacity is an important item for maneuverability submerged and also for safety. The battery speed of ten knots can be maintained for only an hour. After that, a speed of three to four knots can be continued for several hours. When the battery capacity has been used up, the submarine must come to the surface to recharge batteries, just as an airplane must land when its gasoline tanks are empty. Modern submarines are capable of remaining submerged for upwards of 24 hours by running only at a low submerged speed, about three knots, until the battery is used up. That is the reason why so great a proportion of submarines escape from destroyers after having attacked convoys. Darkness often will intervene before the battery is exhausted, and the submarine can escape on the surface under cover of night.

One of the submarine's limitations is in its inability to prevent antisubmarine vessels from tracking it by using their listening devices. Listening devices have been greatly improved since World War I. In 1918, even with inefficient listening devices fitted in antisubmarine vessels, the German submarines suffered a breakdown of morale owing to the large number sunk by destroyer depth charges. The British Admiralty gave no reports on submarine sinkings, and the Germans only knew that submarines never returned to their bases.

A convoy is usually formed in columns of vessels, with the leaders in line. The distance between ships is maintained as close as the experience of the personnel seems to warrant, bearing in mind that danger from collision is as great a risk as even submarine attack.

The escort is placed on the outside of the columns. The destroyers or other antisubmarine vessels are stationed close in where they can turn quickly and steam to the location of the attacking submarine. Cruisers and even battleships and airplane carriers are located far out on the flanks of a convoy, to shield the mass of merchant ships from the gunfire of an attacking surface raider.

The submarine may be informed of the location of a convoy by patrol planes while yet the convoy is out of sight. Then the submarine will use its engines on the surface to place itself in the path of the convoy. Before being discovered by the escort, the submarine submerges and runs on its battery and motors. During this latter time the submarine will be at periscope depth, or about 35 feet, and uses its periscope observations to correct its position relative to the selected target. When a correct position is reached, within short range of its intended victim, the submarine will fire its torpedoes, using its periscope for accurate aim, or else fire the torpedoes while completely submerged, employing the listening device to give the angles of sight for the torpedoes.

The submarine can carry only a limited number of torpedoes, so it will attempt to reach a distance from which a miss is impossible, although the torpedo will run accurately for a distance of 8,000 yards or more. The ideal position for firing is within 1,000 yards of the enemy vessel. Such a maneuver makes the submarine's part a most hazardous one.

Long-distance planes often serve as the eyes for a submarine fleet. Communication between the underwater vessels and the planes is by radio. A submarine can use its radio while submerged to communicate with other submarines and with airplanes. Between submarines, communication by radio is practical up to 100 miles. On the surface, the radio equipment of a submarine is equal in performance to that of a surface warship.

THE airplane bomber has proved most effective against submarines. Oftentimes the submarine can be surprised while on the surface and bombed before it can submerge. Bulletproof armor is carried on the exposed parts of a submarine's hull, but otherwise the hull is most vulnerable to shellfire. A surface vessel can receive a number of shell hits on its hull without seriously impairing its seaworthiness, but not so with the submarine. One shell hit, and the submarine will be unable to submerge.

The personnel of submarines must all be men of experience. They are usually of the

petty officer's rating, especially trained for the duty. In the U. S. Navy a submarine school is maintained to train officers and men for this exacting service. Crews are usually made up from volunteers selected for courage, who can stand the enormous strain of submarine duty without loss of morale. Few men in submarines are over 35 years old, and most of them are much younger.

The modern United States submarine is a vessel of about 1,400 tons surface displacement. Its principal characteristics are habitability, long cruising radius, high surface speed (20 knots) and submerged speed (10 knots for one hour), and the ability to remain 24 hours under water at three knots speed before the batteries are completely discharged. Torpedo rooms are large enough to carry from 15 to 20 torpedoes. The submarine is given most efficient ventilation, and the means of extracting impurities from the air and supplying oxygen deficiencies, when submerged.

The role of our United States submarines in war is to take the offensive off the coast of an enemy. *They are a maximum-purpose vessel*, and can operate both against the enemy's lines of communication at considerable distance from their base, and likewise off our own coast line to break an enemy's blockade.

Twelve German submarines being refueled prior to the spring offensive. The underwater raider is the natural arm of the weaker sea power in war

The submarine is said to be *the* weapon of the weaker sea power. It is relatively inexpensive to build, as compared with the large surface warships. A submarine of the 1,400-ton type costs about $5,000,000, while a cruiser costs upwards of $15,000,000 and a battleship as high as $70,000,000. The submarine is a weapon of great promise, menacing warships and merchant ships alike in all parts of the ocean. In coöperation with airplanes it can extend its vision for hundreds of miles, and it can operate without support from any other vessels.

In war the command of the surface of the sea belongs to the side that owns the most numerous and formidable fleet of surface warships. This advantage enables that side to use the sea with its merchant shipping and all its warships. The weaker side in surface warships cannot command the surface of the sea. This is the reason Germany has used submarines to torpedo every vessel that sails the sea. Everything that moves on the surface is considered by the submarine as an enemy.

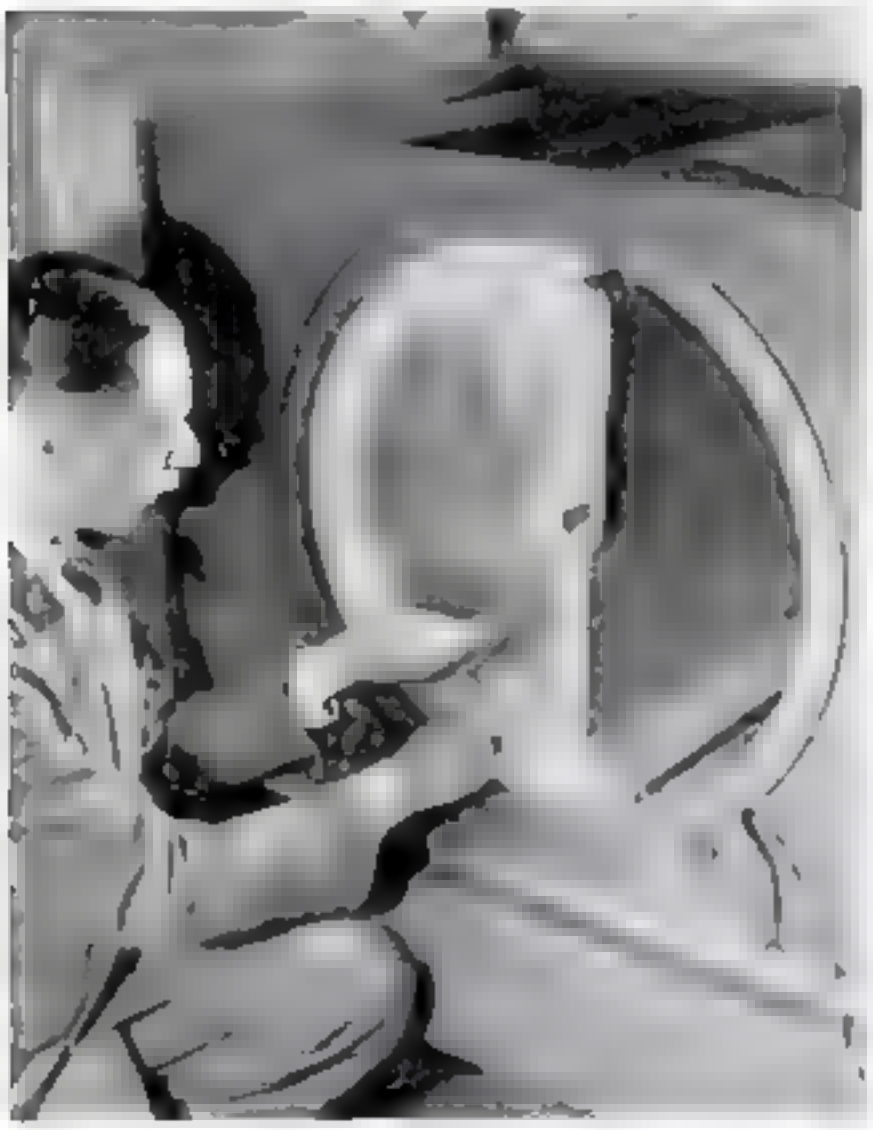
Magic Sand with a Thirst

Silica Gel, Long Used in Industry as a Drier, Now Serves the Housewife, Hobbyist, Sportsman

IF YOU dislike soggy crackers, salt that won't pour, rusted tools, and humid summer days, it's time you made the acquaintance of silica gel. The magic white substance, a friend of long standing to industry, now is making its debut in the household and home workshop as a drying agent. Home owners, housewives, sportsmen, and hobbyists benefit from the remarkable properties of this "sand with a thirst."

Have a chemist analyze it, and he will tell you it is silicon dioxide, the same compound as ordinary seashore sand. The big difference lies in the physical structure of the manufactured variety. It contains innumerable submicroscopic pores, which seize and hold moisture as a magnet does iron. Although the granules will drink up nearly half their weight of water, they will still look and feel perfectly dry. In fact, the newest preparation of silica gel is impregnated with another chemical, cobalt chloride, expressly so that it will show when it is saturated by changing color from blue to pink. Heating silica gel drives out the moisture it has collected, so that it can be used over and over again.

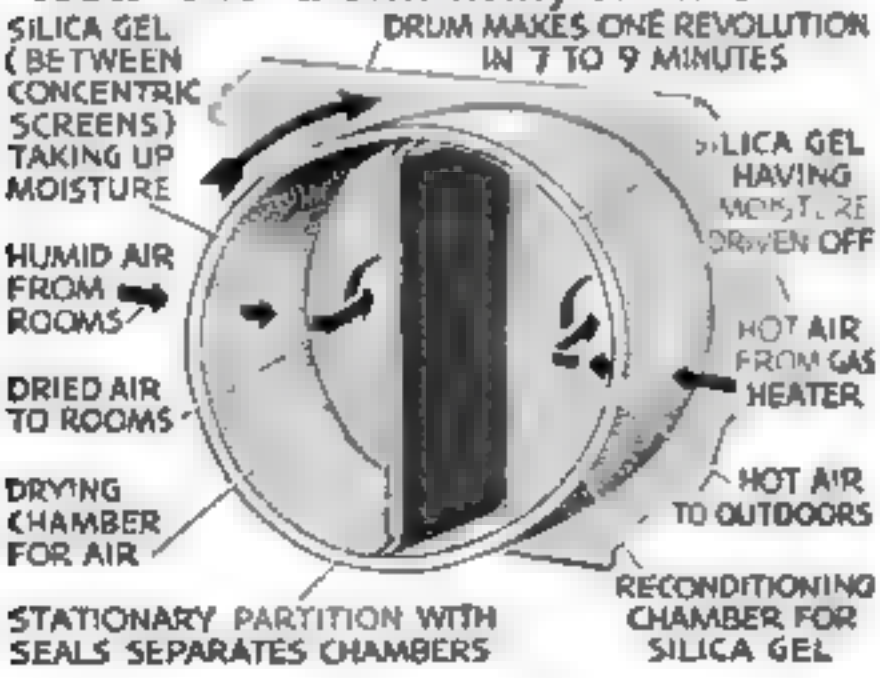
One of the simplest household appliances

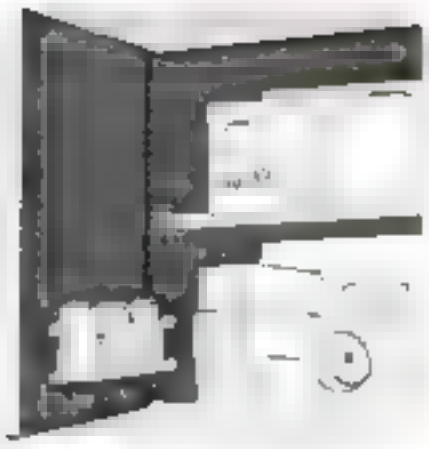


At the left are the insides of a home dehumidifier in which silica gel is put to work to take excess moisture from the air

. . . and this is the outfit assembled. The large outlet at the top is an air duct; the honeycomb grille covers an air filter

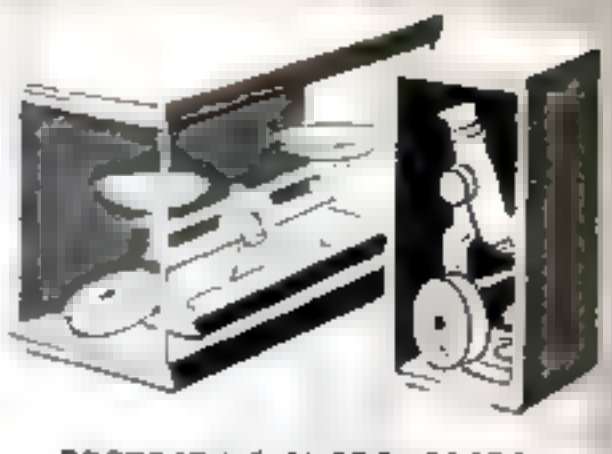
How the Dehumidifier Works





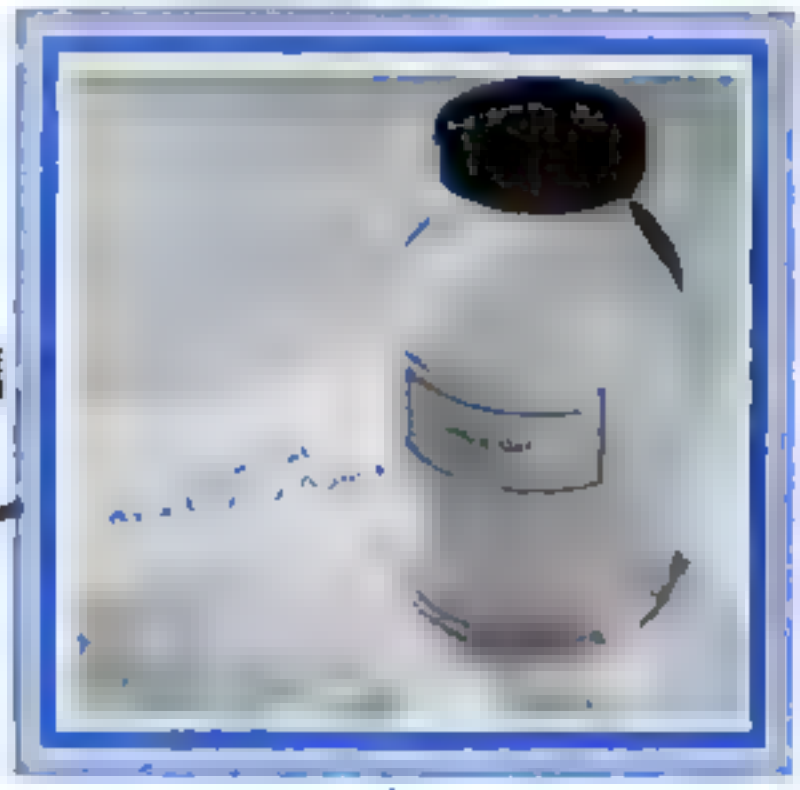
KEEPING CRACKERS, SALT, AND SUGAR DRY

PRESERVING SPORTSMAN'S EQUIPMENT FROM MOISTURE

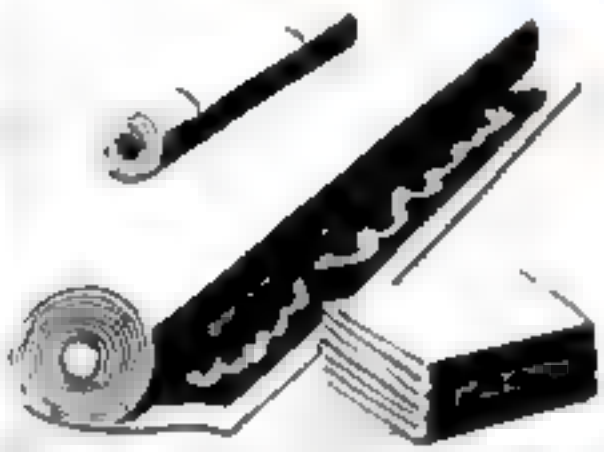


PROTECTING MICROSCOPES AND OTHER VALUABLE LABORATORY INSTRUMENTS

PREVENTING TOOLS FROM RUSTING



KEEPING PHOTO FILM IN TROPICAL CLIMATES



STORING RUGS AND DRAPERIES

CORROSION PROOFING PLANES AND ENGINES DURING SHIPMENT

PRESERVING IMPORTANT PAPERS AND DOCUMENTS

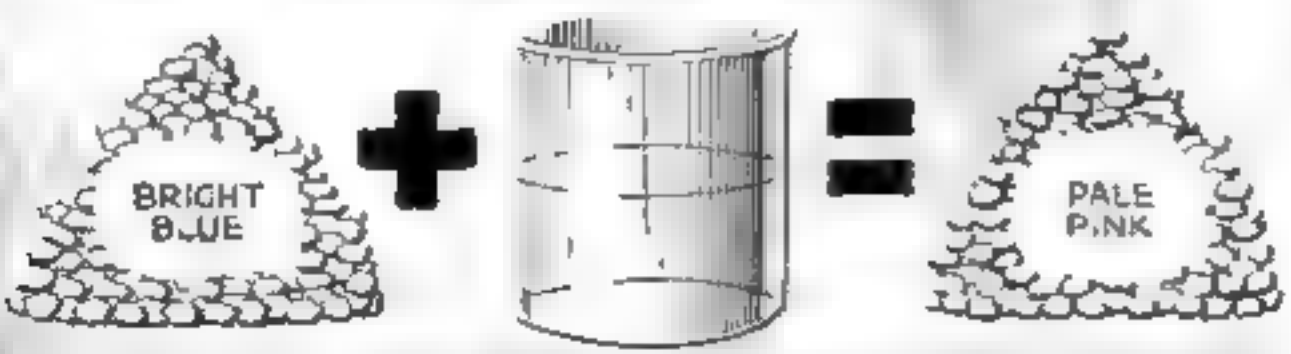
A jar of the "sand with a thirst," and some of its many uses in the home, in the shop, and elsewhere

using silica gel, a perforated aluminum box containing an ounce and a half of the color-changing kind, serves most of the varied purposes illustrated above. Placed beside anything to be kept moisture-free, in a cupboard, drawer, or cabinet, one of the miniature air driers suffices for five cubic feet of space. If more capacity is needed, outfits of larger size are available.

For those who can afford the luxury of an air-conditioned home, a more elaborate silica-gel dehumidifier banishes summer humidity. Into it goes muggy air from the rooms or from outdoors, and dry air comes out. Interconnected with a central air-cooling and circulating system, the device eliminates any feeling of dampness in chilled air, and reduces the number of degrees that the air must be cooled for comfort.

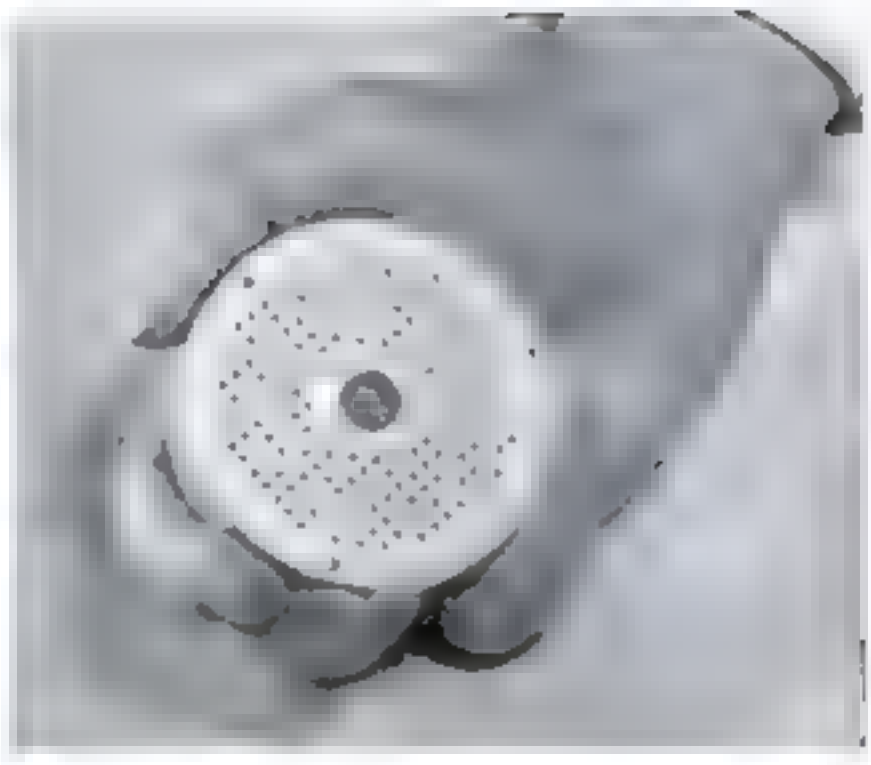
In industry, similar or larger installations

NEW "SELF-INDICATING" SILICA GEL



SHOWS BY COLOR CHANGE WHEN IT HAS TAKEN UP ITS CAPACITY OF MOISTURE

Because ordinary silica gel looks just the same after soaking up half its weight of water, this new preparation was made to show when it is saturated

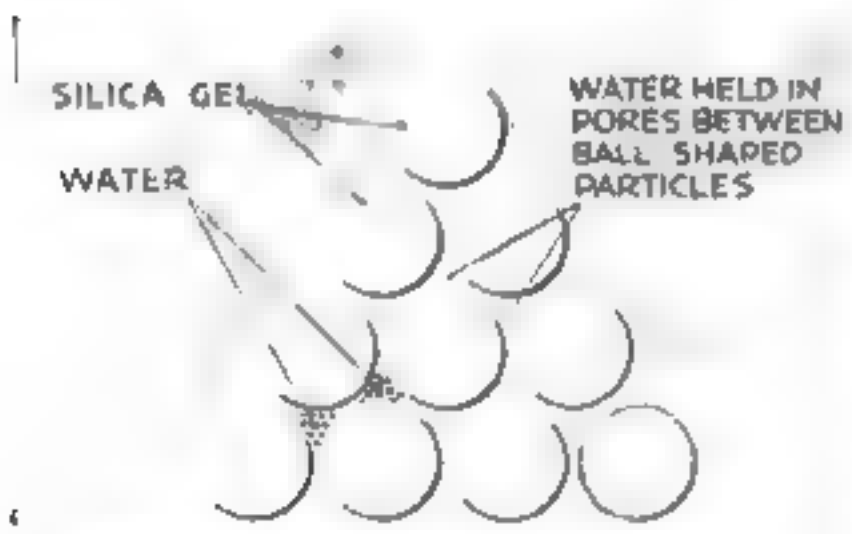


A miniature air drier containing an ounce and a half of the magic material. When saturated, it is restored to use by heating in an oven

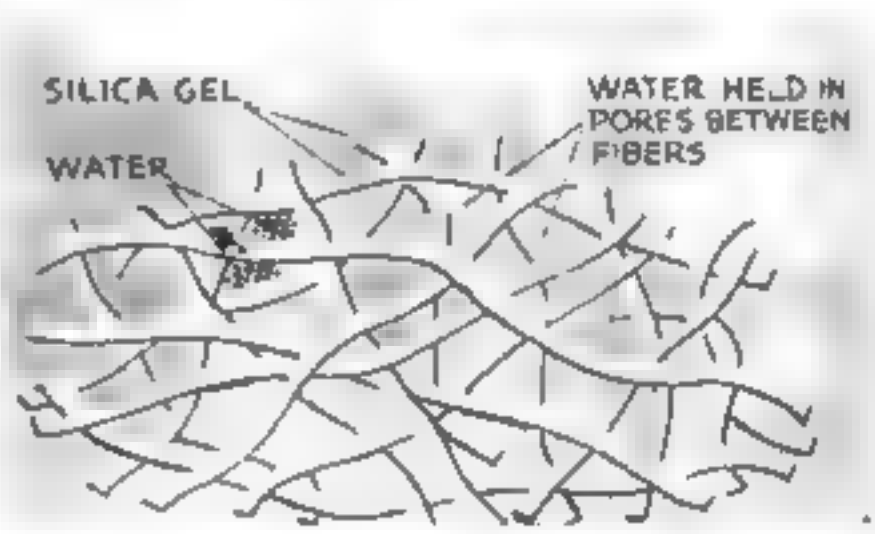
rigidly control humidity in packaging, candy-making, and other operations. Another major use of silica gel is to protect all kinds of merchandise, including airplanes, from moisture during shipment by land or [redacted]

Treated with acid, a silicate such as water glass becomes a jellylike mass, which hardens into silica gel. The first world war ended before Dr. W. A. Patrick, famous American chemist, perfected its large-scale manufacture by this process. He intended to use it in gas masks, where it may yet prove its worth for trapping poison gases.

MORE THAN AN ACRE OF PORE SURFACE PACKED IN ONE CUBIC INCH

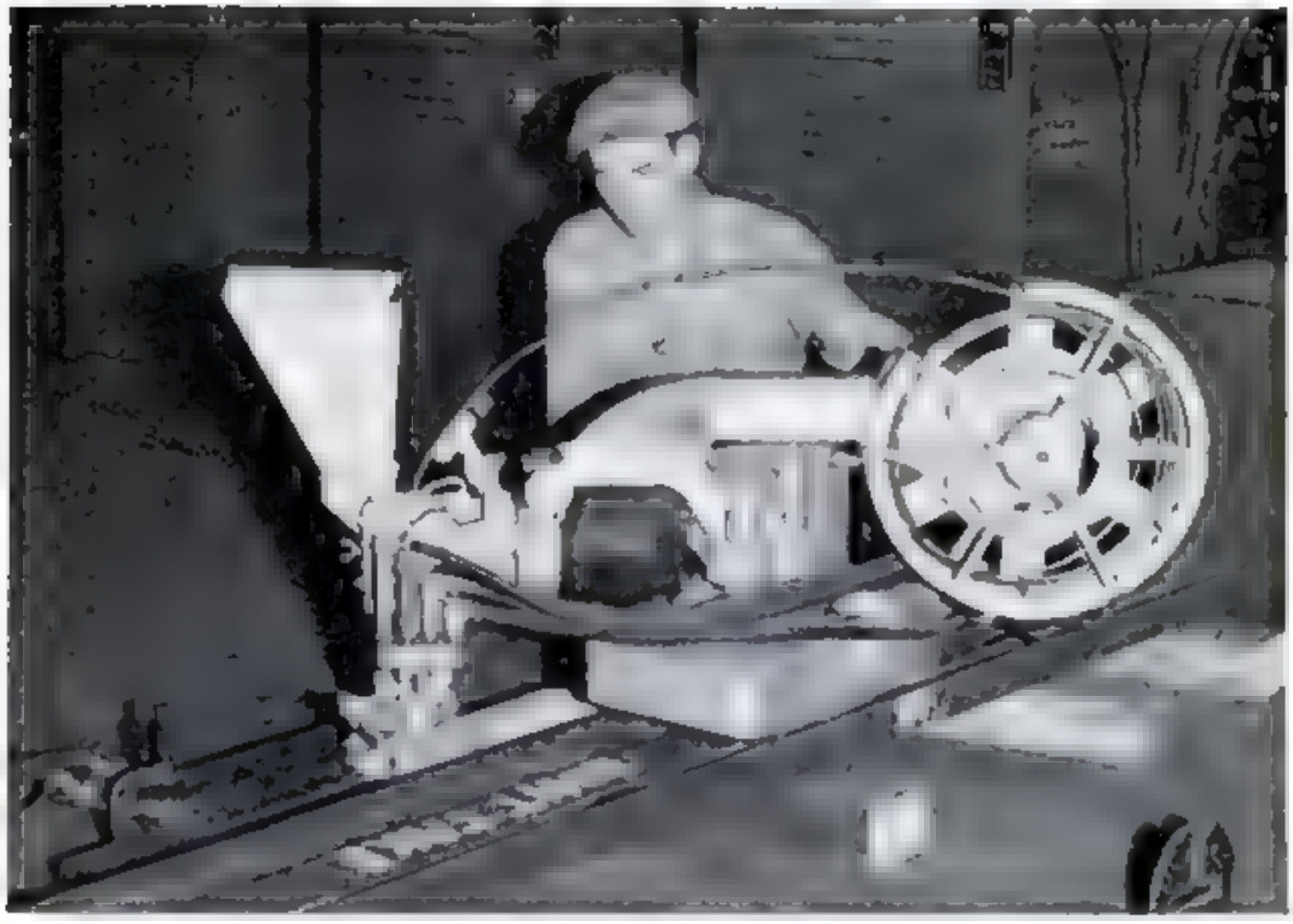


Two theories of silica gel: ball-like particles



. . or interlaced fibers resembling raw cotton

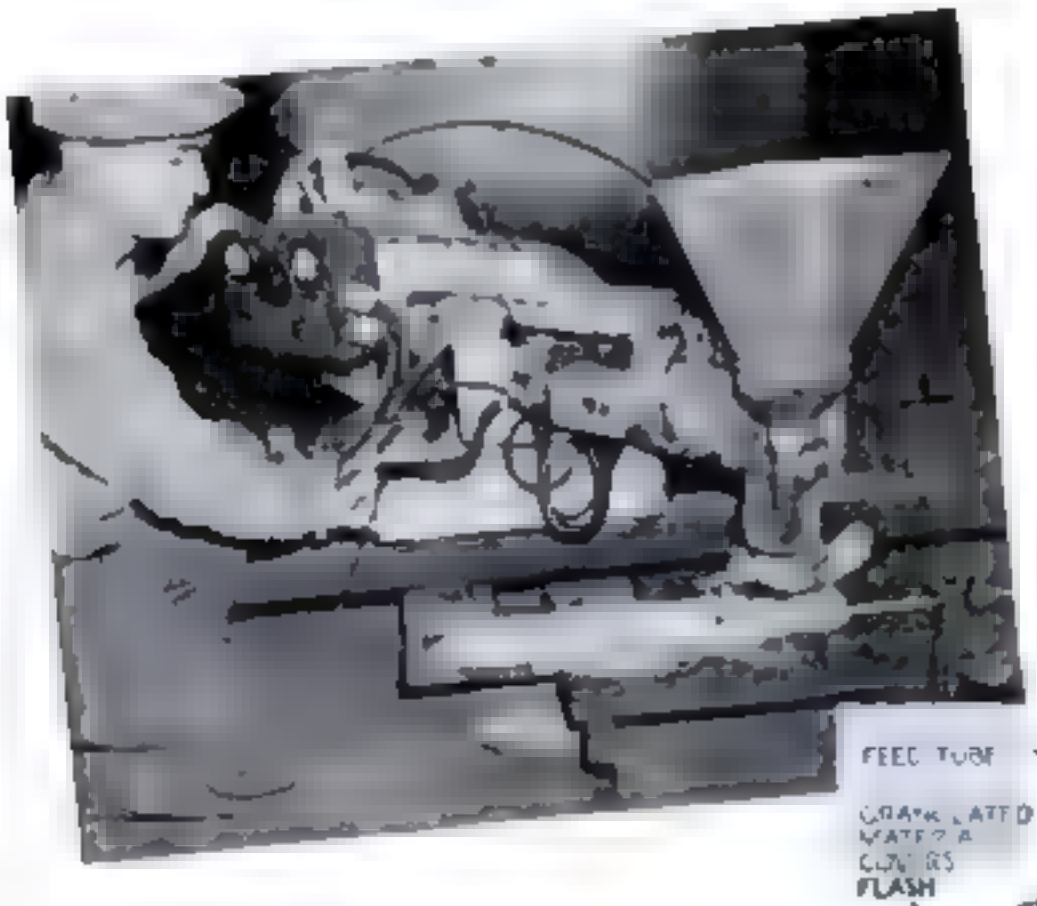
The water-holding surface of the pores in a single cubic inch of silica gel totals more than an acre



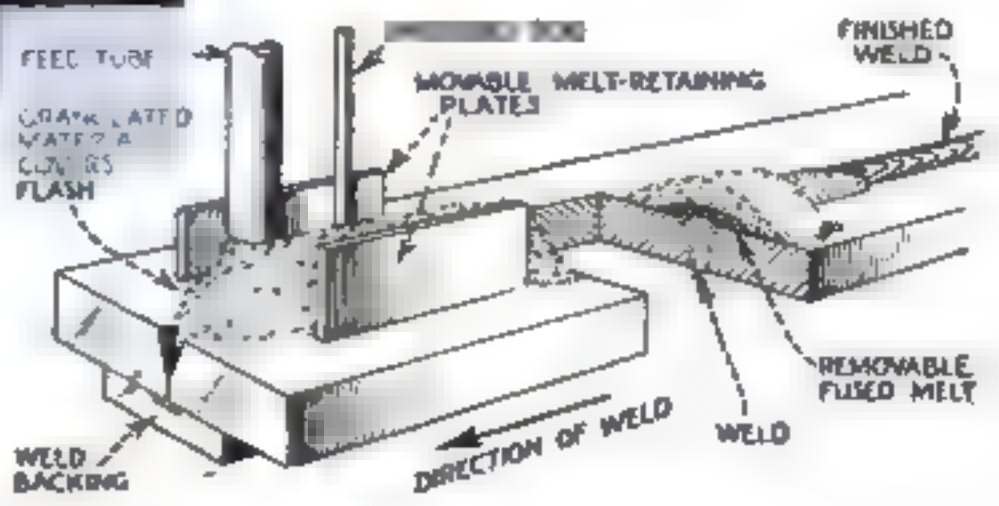
Flashless welder in action. The welding electrode is fed from the reel at the back of the machine

Automatic Flashless Welder

BUILDING of ships and other products of steel is being speeded with an automatic electric welding machine which works equally well on curved or flat plates or parts. In addition to speed, it has the advantage of eliminating the flashing arc, smoke, and flying particles of hot metal that accompany open-arc electric welding. This is done by blanketing the welding electrode and the edges to be joined with a granulated material which muffles the arc, excludes the atmospheric gases from the weld, and concentrates the heat in the welding zone. This material feeds from a hopper as the machine moves along a rail beside the joint to be welded, and it is sucked up and returned to the hopper as the weld is completed.



Granulated material fed from the hopper seen above blankets the arc as the unit moves along a rail beside the joint being welded. The welding voltage, current, speed, and electrode feed are automatically regulated by the electric controls



Wardrobes for Soldiers

WIDE VARIETY OF UNIFORMS MAKES AMERICAN ENLISTED MAN ONE OF WORLD'S BEST-DRESSED FIGHTERS

By DAVID M. STEARNS

THE busiest haberdashery in the United States today is the Army Quartermaster Corps. It has the job of providing uniforms, complete from underwear to overcoats and from shoe laces to hats, for the entire enlisted personnel of the Army.

That means a lot more than dealing out a uniform with two pairs of pants to each recruit, because the enlisted man in the American Army is one of the best-dressed soldiers in the world. He has different uniforms for summer and winter, for field work and garrison duty, for ditch-digging and parading. Specialists, such as mechanics, cavalrymen, parachute and armored-force troops, have, in addition to their regular uniforms, extra outfits designed to meet their particular needs.

Add the specialized items to the equipment that is issued to every doughboy and it makes an impressive list. The office of the Quartermaster General in Washington, for example, has samples of 22 kinds of hats, 17 styles of gloves and mittens, and 15 types of boots and shoes, representing just a few of the things that must be kept in stock to supply the soldiers.

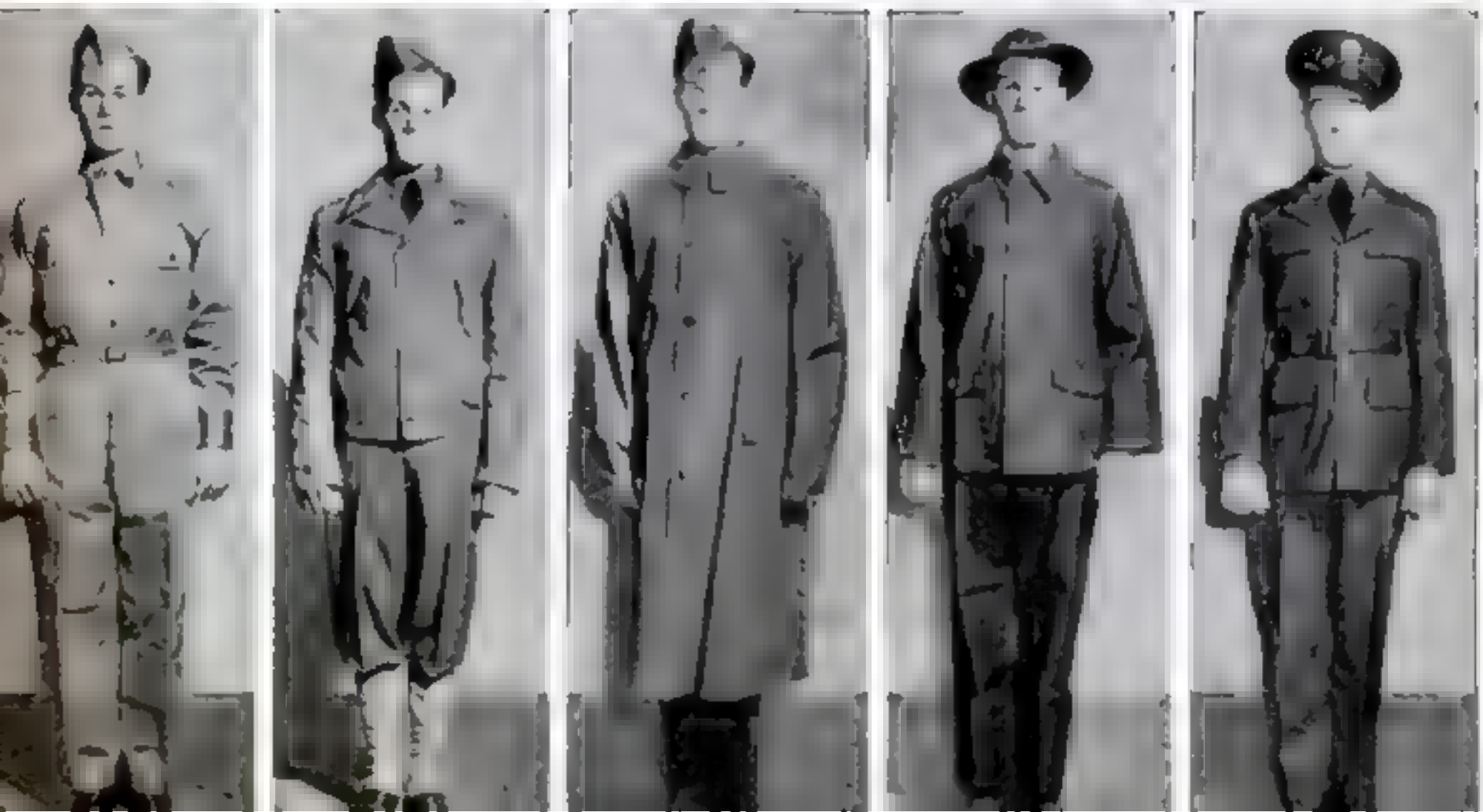
The glove list includes such varying designs as bearskin mittens for troops in Alaska, fleece-lined horsehide mittens with slits across the palms so a soldier can get his fingers out to work a trigger without taking the mittens off, asbestos gloves for handling hot stuff, suede gloves for Army nurses, and leather gloves with reënforcements riveted on fingers and palms so barbed wire can be handled without lacerating a soldier's hands.

Hats range from headpieces for tank drivers and firemen to cloth-covered fiber helmets for wear in the tropics. Shoes run from hip boots (two styles) down to oxfords for the nurses. There is even a special shoe for Philippine scouts because the ordinary service shoe doesn't fit their feet.

A list of garments the Q.M. department must keep on hand reads like a mail-order

An enlisted man in the U. S. Army boasts an outfit for every occasion. Below is a soldier dressed for:

Hot Weather | Field Work | Rainy Weather | Hard Labor | Formal Functions



In the textile research laboratory of the U.S. Army Quartermaster Depot at Philadelphia, a technician uses a microprojector to examine wool fibers from cloth for uniforms and blankets. Fibers are put on a slide and placed in the beam of light. This throws a magnified image on the paper in front of the operator, who checks for uniformity and size of fibers

Photographs by Ralph Morse

catalogue. Every soldier gets, among other things, woolen shirts and trousers for cold weather, khaki ones for summer, a wool-lined mackinaw for field work in winter, blue denim trousers and jackets for dirty work, and a heavy overcoat for "putting on the dog" in cold weather.

One of the most popular items with the soldiers is the new lightweight, wool-lined, wind and water-repellent field jacket. It has a belted and pleated back, slide fastener and buttons on the front, and button flaps over the pockets. The collar can be buttoned tightly around the neck, or worn open. When the first of these were issued recent-

Any time a soldier freezes, it will not be the Army's fault. Here are some cold-weather clothes for:

Garrison Duty — **Armored Force** — **These three outfits are designed for troops in Alaska**

ly, even the officers wanted some. However, commissioned officers are supposed to supply their own clothing, and the Q.M. Corps needed all the jackets it could get for the enlisted men.

For soldiers in mechanized outfits, a "monkey suit" has been developed that makes a soldier look like a teddy bear, but does a good job of keeping him warm and dry. It is made in two pieces, with overall-type trousers and knitted bands at ankles, wrists, neck, and waist. Wind and water-repellent cloth are used for the outer layer, with a heavy wool lining. A helmet of the same material, with a flap that extends down over the jacket collar to protect the back of the wearer's

This "Densometer" tests wind resistance of fabrics. The oil-filled upper part of the column pushes air through the cloth stretched across the hole at the bottom. Rate of fall of the column is checked by watch

Below are some of the 15 styles of boots and shoes supplied to soldiers. Back row, left to right: shoe pac with leather upper, rubber bottom; half-moccasin leather boot with calks; legging-top leather boot for cavalrymen, engineers, etc.; high-top shoe pac. Front row: leather logger's boot; service shoe; garrison shoe; Philippine Scout shoe; felt inner shoe for rubber boots

Slide fasteners for use on uniforms are tried out on this machine. It zips the fastener up and down while a counter in the background keeps the score. A belt rings at the end of 10 000 zips

neck, and two-buckle arctics, complete the outfit.

Since nothing is available commercially that meets the Army requirements, the Q.M. Corps develops its own ideas and those of the Army in general in designing soldiers' clothing. Each of the many garments now in use represents months, in some cases years, of experimentation and research.

The idea for a new type of garment usually originates in the enlisted personnel or among the officers of the Army. When somebody thinks that a change is in order, he submits his suggestions to the Q.M. department. Officers trained in textile schools, and civilian workers on the Q.M. staff search the commercial

Below, more Army footwear Back row, left to right: Rubber knee boot; two-buckle arctic (used with armored-force combat suit) has cloth top, rubber bottom; four-buckle rubber arctic; tight-fitting rubber knee boot. Front row Rubber hip boot; special ankle-fit hip boot for troops in Alaska. (Samples at Quartermaster General's office)

field for designs and fabrics. Then they combine what they have found with the Army suggestions and turn out an experimental model. This is submitted to a technical board in Washington, representing all branches of the service. If the board approves, the model goes to the general staff, and finally to the Chief of Staff for a final O. K.

After that a trial order is made up and shipped to some outfit in the field for a work-out. When the garments have been in use long enough to see how good they are, a report is submitted to the Q.M. Corps, possibly with suggestions for improvements. Then general specifications are drawn up and manufacturers are invited to bid on large orders.

Most Army clothing is made by commercial manufacturers from cloth, thread, buttons, and fittings supplied by the Army. The Q.M. boys know just how many garments can be turned out from a given amount of cloth, down to the last yard, and the contractor has to return even the scraps to the Army after the job is done. These are

HATS

There's plenty of variety in what the well-dressed soldier will wear on his head. At the far left is a helmet of fiber covered with khaki cloth, for use in the tropics. For the other extreme of climate is the winter field cap

Left to right: Fireman's hat; campaign or service hat; the tropical helmet; dress-up garrison cap; helmet for combat suit

•

Metal helmet for tankers; blue denim work cap; fur-lined cap for use by men in Alaska; khaki field cap; sou'wester for rain

•

Motor-cycle rider's cap; blue denim mechanic's cap; winter field cap (shown above); fur-lined cold-weather caps; cap for use by Army nurses

•

Old-style motor-cycle cap; hat for cooks and bakers; khaki mechanic's or work cap; service cap in wool and khaki; helmet for Air Corps flyers

weighed and the weight added to that of the garments to see that nothing is lost.

To make sure that it is getting the best material for its needs, the Q.M. Corps maintains at its Philadelphia depot what is probably the best-equipped textile-testing laboratory in the country. There fabrics are tested for strength, waterproof qualities, and durability. Thread and cords are checked for breaking strain, color, and even the number of yards of thread per spool. Slide fasteners are hooked to a machine devised by the laboratory staff and opened and closed 10,000 times to test them for wear.

Another ingenious machine developed by the laboratory staff is used to test the warmth-retaining characteristics of various fabrics. It consists of an electrically heated cylinder around which the cloth is clamped. The amount of current required to keep the cylinder at body temperature for a given period of time while a fan is blowing cold air against the cloth is measured carefully. By comparison with cloth which has already been tested in the field, this gives an index of how effective the new fabric will be.

GLOVES

Seventeen styles of mittens and gloves are kept in stock by the Quartermaster Corps. At right are the knit woolen O.D. glove issued to all men in cold climates, and a fleece-lined horsehide mitten with trigger slit

Left to right: Leather work gloves; asbestos mittens; leather work mittens; leather gloves reenforced for barbed wire

•

Gauntlet-style leather mittens, blue woolen knit [redacted]' gloves; bearskin mitt (Alaska); gauntlet-style leather work gloves

•

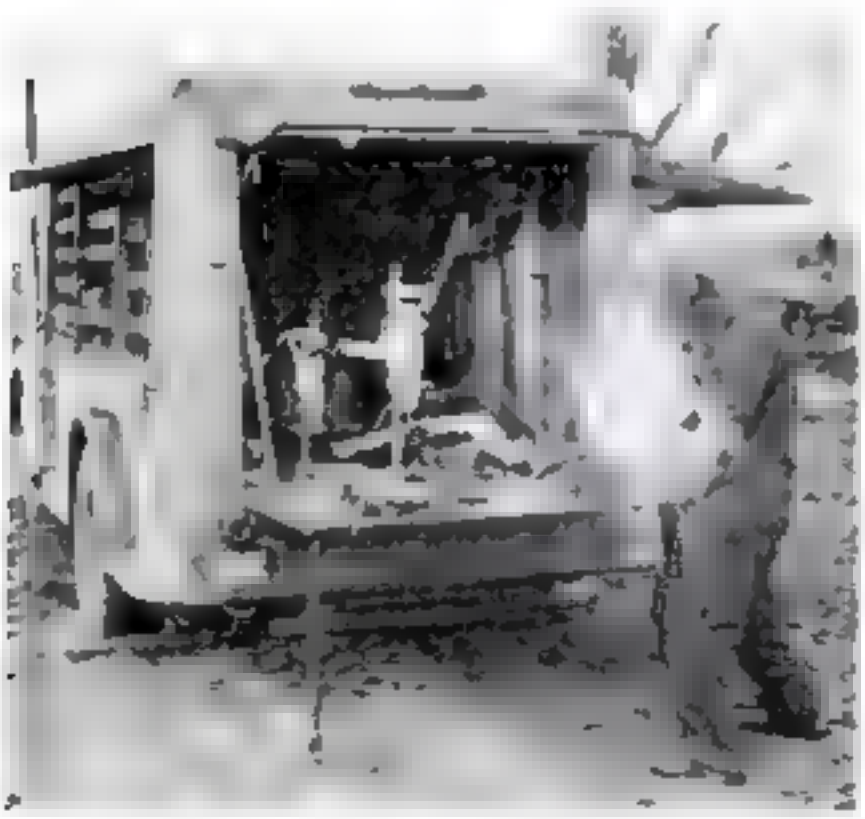
Leather gloves for motorcycle riders, flyers, etc.; horsehide mittens (shown above); riding gloves for cavalry; leather mittens

•

More leather work gloves; O.D. woolen gloves (shown above); suede dress gloves; white cotton dress gloves (tropics); nurses' gloves

Twenty-Ton-Atom Smasher Will Generate 8,000,000 Volts

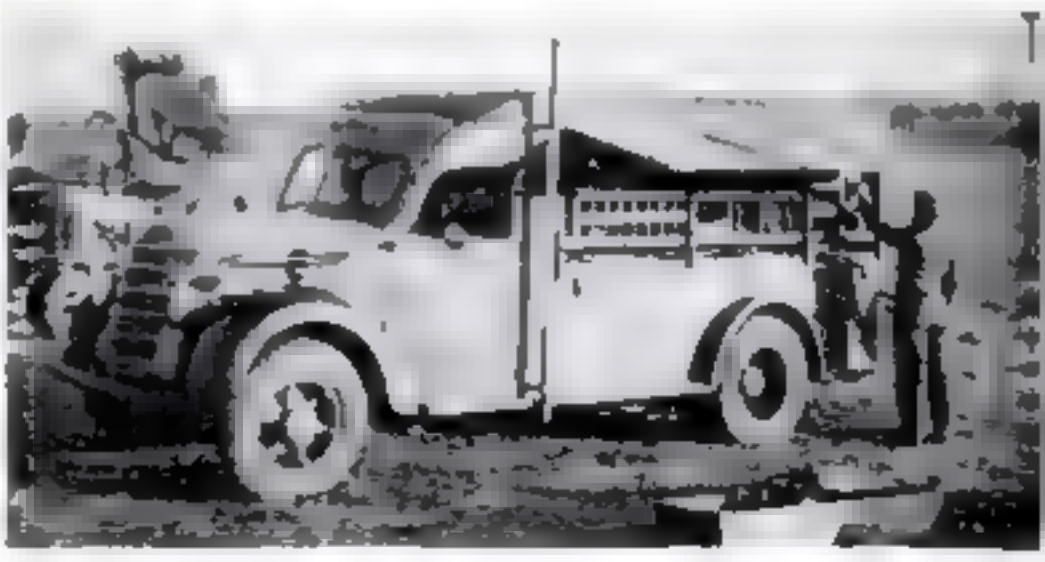
TO DELVE deeper into the secrets of the atoms, a 20-ton atom smasher, shown above as it looked during assembly, has been built for Notre Dame University. Capable of developing energy of 8,000,000 volts, it will be used for experiments in the disintegration of nuclei by high-speed electrons, and in the production of radioactive elements by X rays. For this latter work, it is believed that the X rays developed by the machine will be the most penetrating of their kind ever produced.



Above, electric welding down on the farm, by means of a machine shop mounted in a truck. Right, the truck drawn up in a harvest field

Farm Machine Shop on Wheels

REPAIRING harvesting combines and similar machinery in the field is the purpose for which this traveling machine shop mounted in a truck was developed. Generators hooked to the truck engine supply current for welding, and also for operating floodlights.



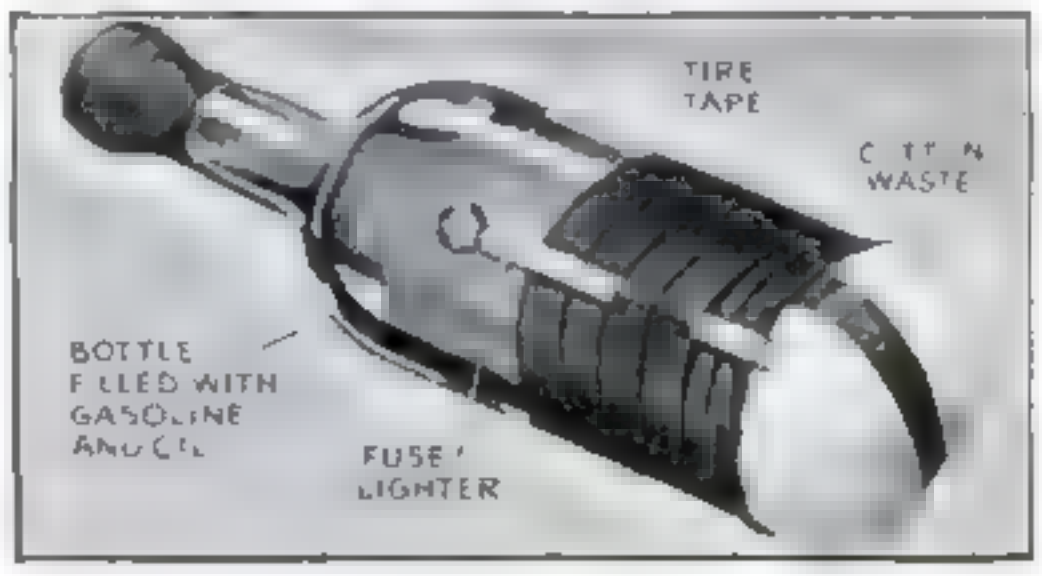
Flames envelop a tank hit by a "Molotov cocktail," a blazing bottle filled with gasoline and oil

HOMEMADE TANK BOMBS

THERE'S more than one way to stop a tank, and one of the simplest is the "Molotov cocktail" which has been used successfully on European battlefields. Lieut. Col. William F. Heavey, U. S. Army Corps of Engineers, writing in a recent issue of the "Infantry Journal," states that an efficient bomb of this type can be made from an ordinary quart bottle. This is filled with a mixture, half gasoline and half oil or creosote, as gasoline alone burns out too quickly. A good-sized piece of cotton waste is taped to the bottom of the bottle, and an engineer's fuse lighter to the side. In use, gasoline is poured on the waste, the lighter is pulled and the bomb is thrown. Because these devices can be dangerous to throwers as well as to targets, Col. Heavey suggests that troops should practice for a while with water-filled bombs before using an explosive mixture. A direct hit will usually create enough heat to force the crew to abandon the tank in a hurry.

The corporal pulls the fuse lighter taped to the side of the bottle, and heaves it overhand at the oncoming tank

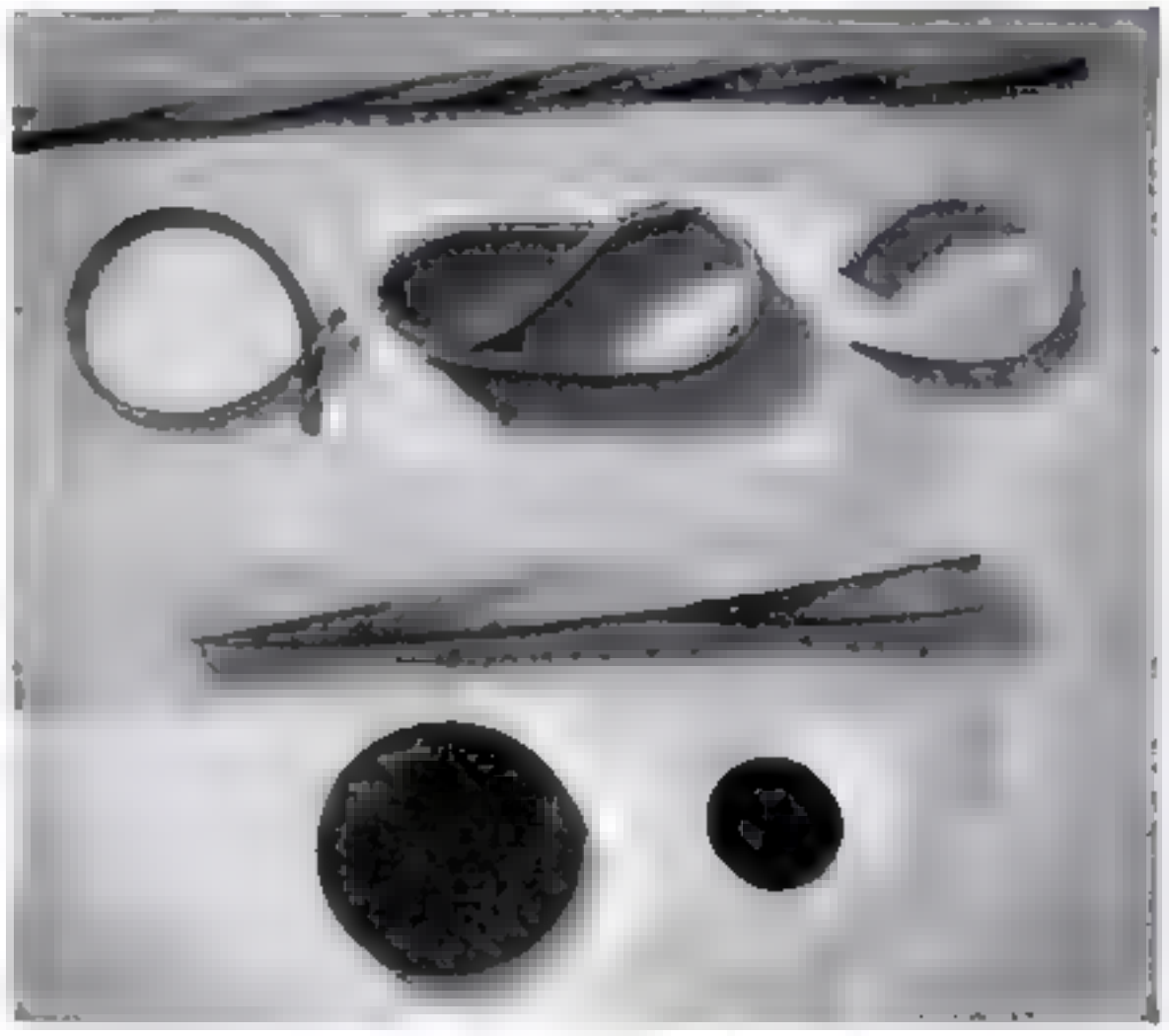
Detail showing how the homemade tank stopper is made



Twisting a stick of oak. Soaked in a concentrated urea solution and heated, the wood is easily shaped

Simple Chemical Bath Makes Wood Plastic

STRIPS of wood literally can be tied in knots without breaking, and sawdust can be molded into solid blocks, with a process developed at the U. S. Forest Products Laboratory at Madison, Wis. It consists of soaking the wood in a concentrated solution of urea, drying, and then heating it to about 212 degrees Fahrenheit. At this temperature the wood becomes plastic and can be formed into any desired shape. Upon cooling it retains that shape, but regains its pristine strength and hardness. Sawdust and chips, put through the same process, can be pressed in molds while heated. After cooling, the products thus formed have practically the strength of the original wood. The process was developed by W. K. Loughborough of the laboratory's timber physics department.



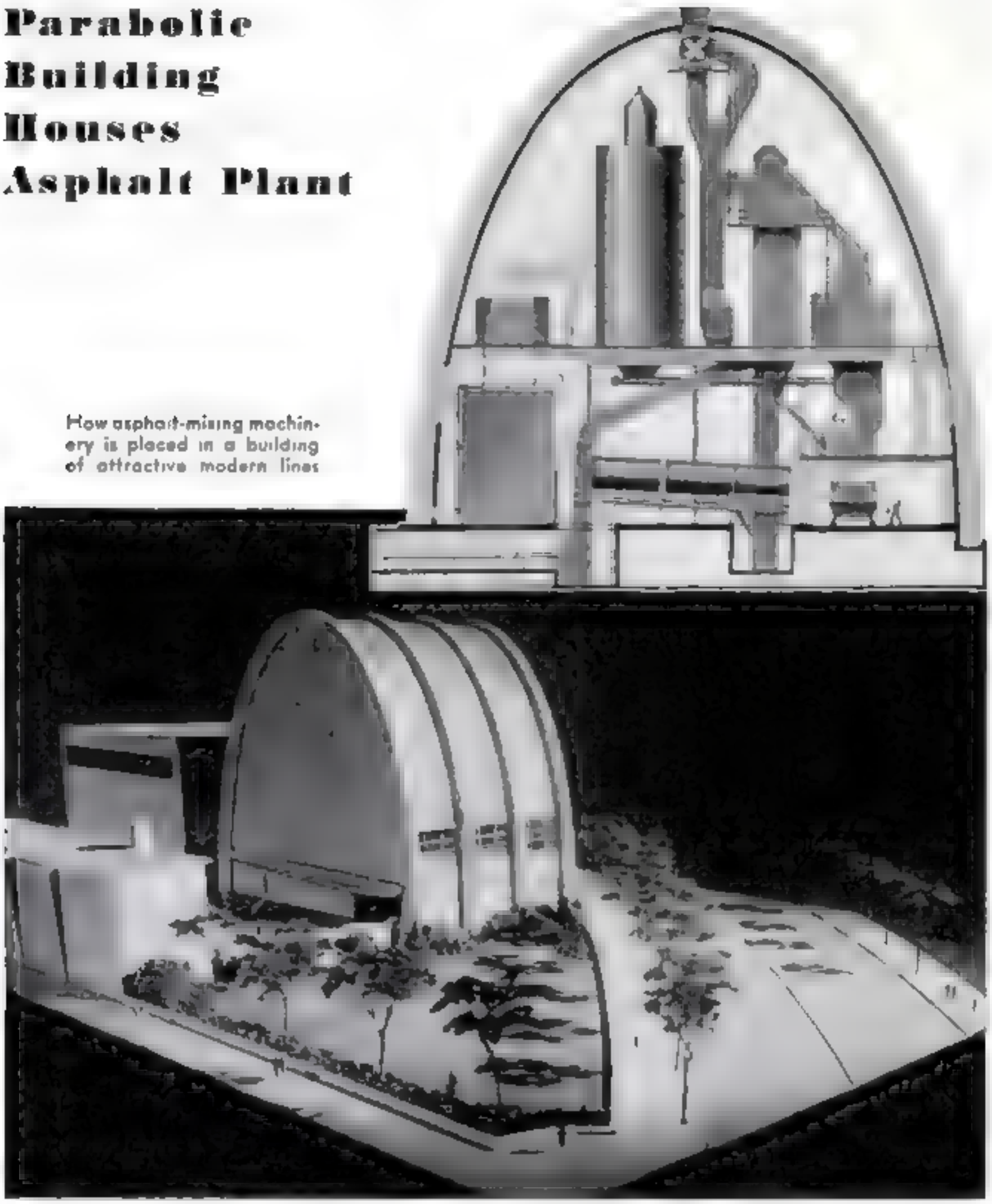
Samples of plasticized wood. The figure-8 piece was bent with the grain; the loop at the right, against the grain. The large disk was laminated by pressing small pieces; the small disk was molded from sawdust

W. K. Loughborough, of the U. S. Forest Products Laboratory, placing a piece of oak in urea solution

After soaking and drying, wood is heated in an oven. Shaped while hot, it regains hardness upon cooling

Parabolic Building Houses Asphalt Plant

How asphalt-mixing machinery is placed in a building of attractive modern lines

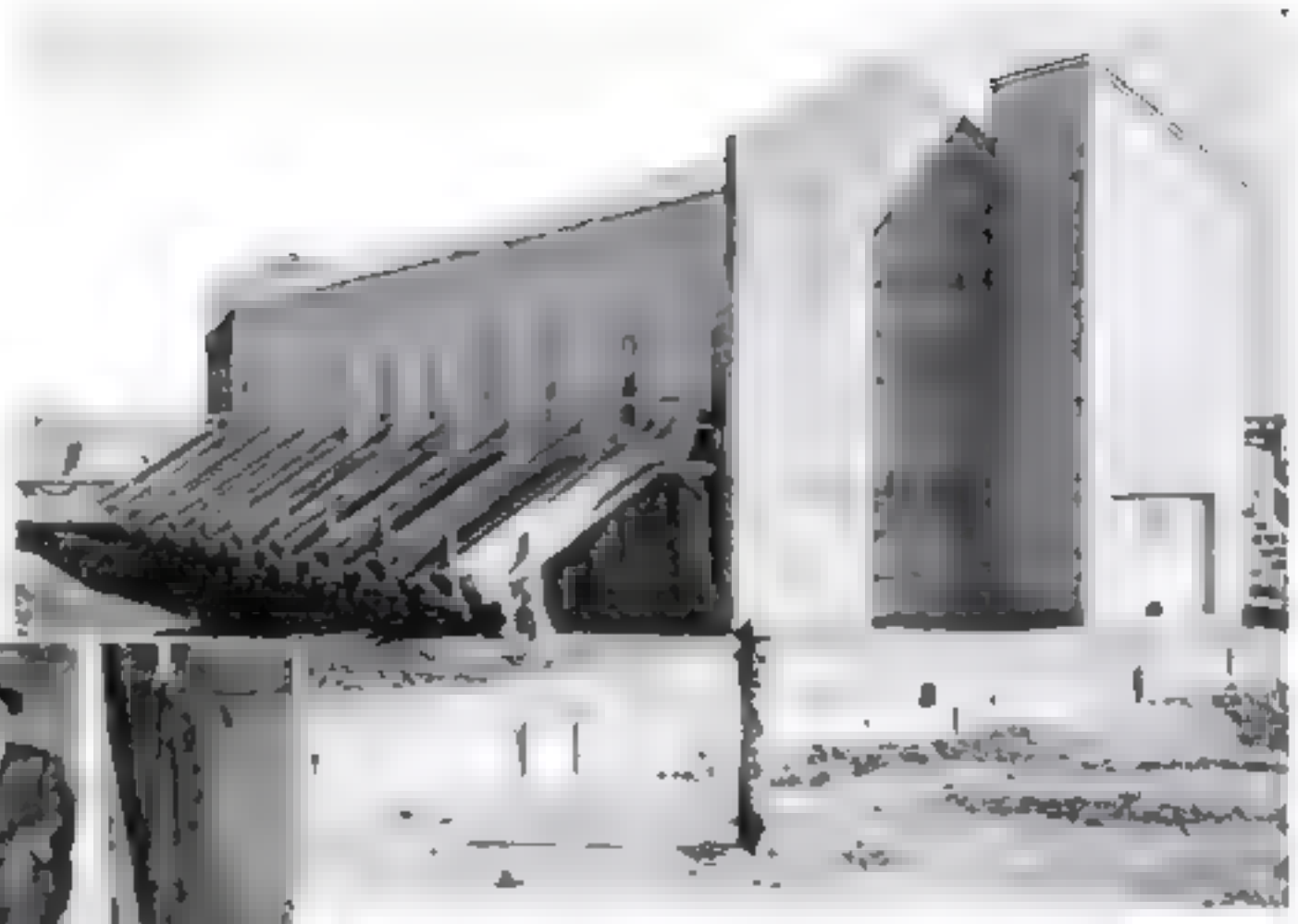


Model of New York's municipal asphalt plant, now under construction. A conveyor will bring materials under the East River Drive

A GOOD example of how engineers and architects can work together to design an industrial plant that will harmonize with its surroundings is this municipal asphalt plant, now under construction for the Borough of Manhattan, New York City, on the East River Drive. Machinery to be housed in the plant made a tall building a necessity. At the same time, it was important to avoid creating an eyesore. The concrete structure was therefore designed around the machinery, with windows only where they were necessary to admit daylight for inspection of moving apparatus. Materials for mixing the asphalt can be brought to the plant in barges, from which a conveyor belt running under the Drive will carry them into the plant. The exterior of the building was designed by Ely Jacques Kahn and Robert Allan Jacobs, New York architects.

All buildings handling explosives at the new Hercules powder plant at Radford, Va., have emergency chutes

Below, C. A. Higgins, president of the company, shows how he'd get away from an explosion



Safety Chutes Provide Quick Exit from New Powder Plant

WHEN something goes wrong in a gunpowder factory, etiquette prescribes getting out — and quickly! Dignity goes by the boards as C. A. Higgins, president of the Hercules Powder Company, sets an example for his employees. He's trying out one of a series of escape chutes, resembling amusement-park devices, installed at his company's new Radford, Va., factory. The $44,100,000 plant will help supply ammunition for defense.

Antisubmarine-Net Tender Is Launched for U. S. Navy

Twelve craft like the *Locust*, shown being launched, will guard U. S. ports

PICTURED during her launching at Cleveland, the 158-foot net tender *Locust* represents a new kind of U. S. naval vessel. Named after trees, twelve of these craft have been ordered, to handle antisubmarine nets that would be stretched across entrances to important naval and commercial harbors in time of war. Made of steel mesh, the nets have movable sections that can be swung open, like gates, to permit passage of friendly ships.

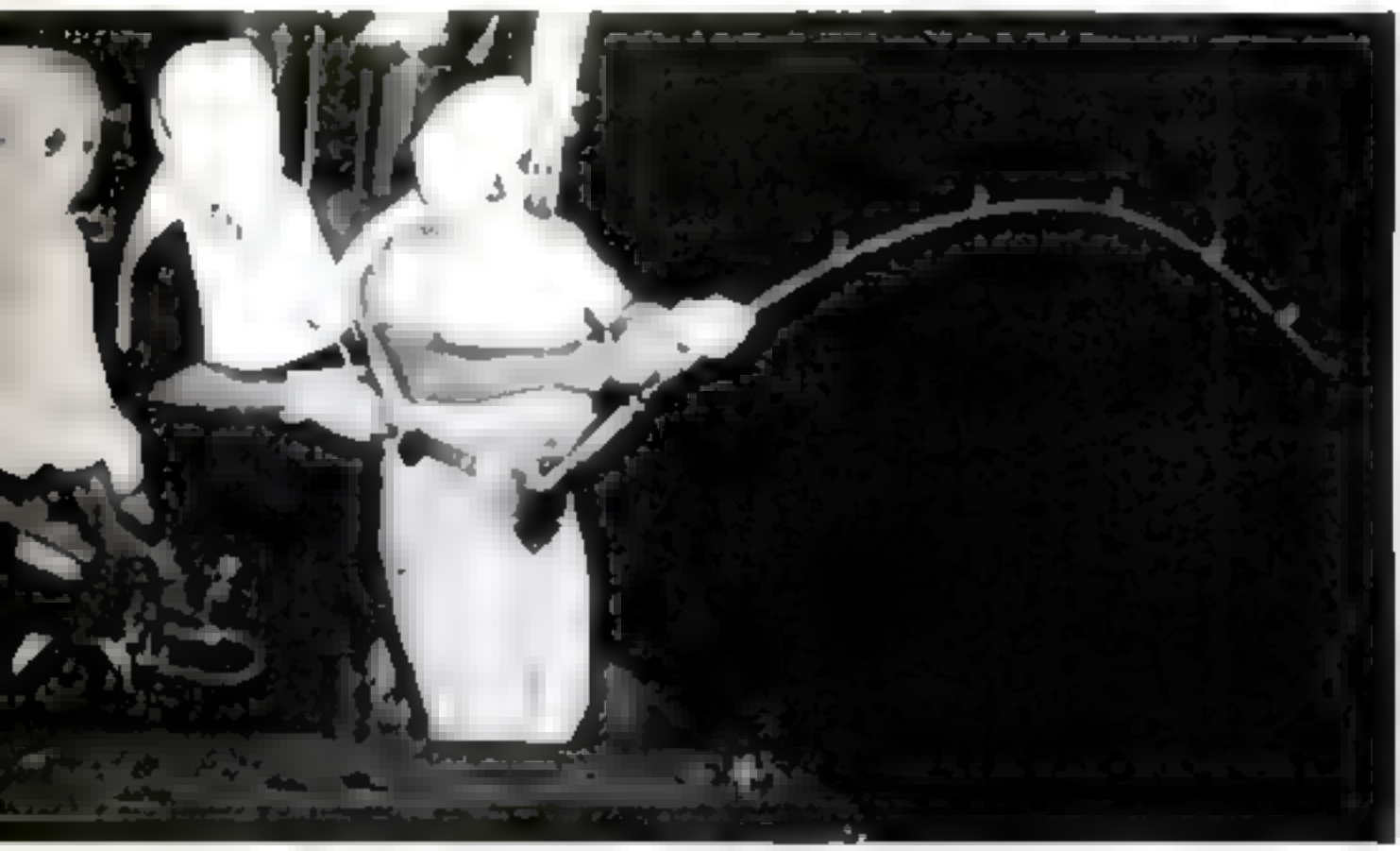
A close-up of the tentacles and beak of a squid caught off the coast of Peru by the Lerner-American Museum Expedition. Handling squid is delicate work, as the sharp, parrotlike beak can bite off a hook—or finger

Photos courtesy of [illegible] Museum of Natural History

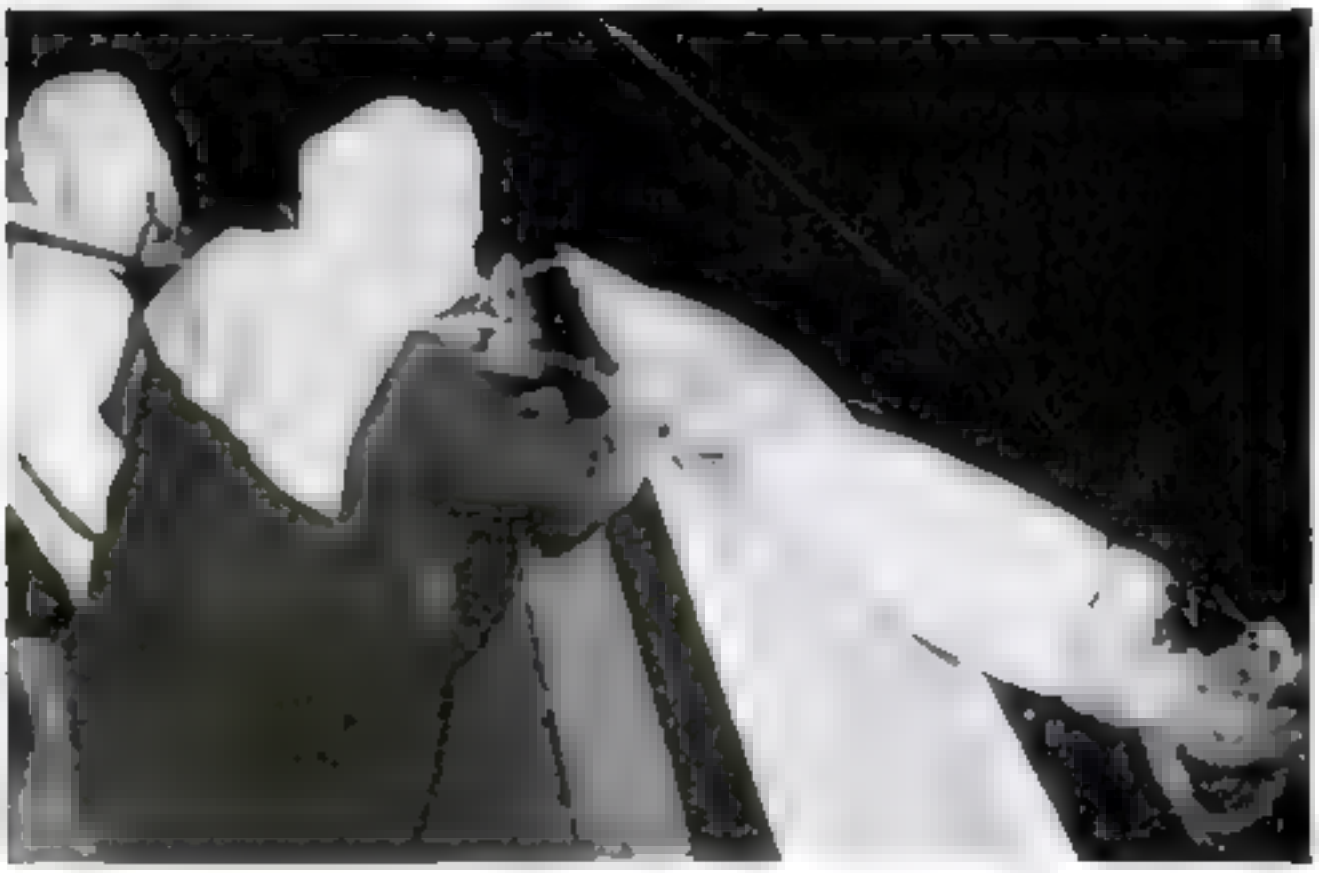
Squidding

Collecting Specimens for Study Provides Thrilling Sport for a Scientific Fishing Expedition

SQUIDDING is not a pastime for the average game fisherman. Squid have a nasty habit of squirting an inky irritant on their captors, and their tentacles can cut and tear the toughest skin. Their parrotlike beaks can make quick work of snapping off a man's finger. But, in the interests of science, Michael Lerner, leader of the 1941 Lerner-American Museum of Natural History Big Game Fish Expedition, caught a number of Pacific gray squid recently in South American waters. The catch ranged in size from four to seven feet in length, and the latter size tipped the scales at 75 pounds. They were found in deep water, and the fishing was best between midnight and dawn. Most of them were caught in the Pacific off the coast of Peru. The average time required to bring a squid to the surface was fifteen minutes. Photographs on the following pages show the scientific fishermen in action.



A Weird Battle by Night in the South Pacific Between Hooded Fishermen and Ocean Monsters Using Nature's Oddest Weapons



"BOATING" A SQUID. Aboard the fishing boat *Alone*, about 70 miles off the Peruvian Coast, Michael Lerner, leader of the expedition, gets a squid strike. He is using a rod and reel of the type commonly used by game fishermen, with a 15-thread line. Gang hooks, a dozen or so to the line in rather close clusters, are baited with chunks of other squid or fish. The men wear hoods for protection against the irritating "ink" ejected by squid while being booted. A squid of average size (about five feet) puts up a 15-minute fight before he can be gaffed, as shown at the left, and dragged aboard. As he comes to the surface, he lets fly with his stinging barrage

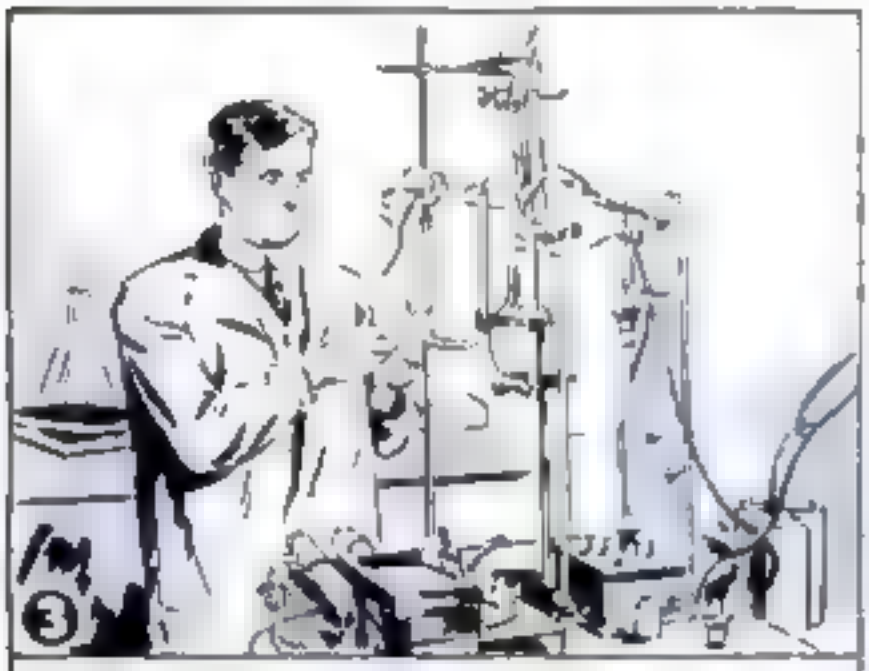
SQUID LEAVES ITS MARK on the hands of Capt. Douglas Osborn, skipper of the *Alora*. The scratches were made by the suction cups on the tentacles, which are lined with sharp cartilaginous material. From midnight to dawn were the best hours for squidding. Smaller squid were found near the surface, larger ones farther down, usually over rocky bottom areas

PACKING UP THE CATCH. Ashore at Talara, Peru, expedition members pack up their collections of fish to be shipped back to the American Museum of Natural History for study. Specimens are packed in formalin, in sealed metal cases inside wooden containers. Main purpose of the expedition was to check up on the migrations of swordfish and marlin

Here's My Story

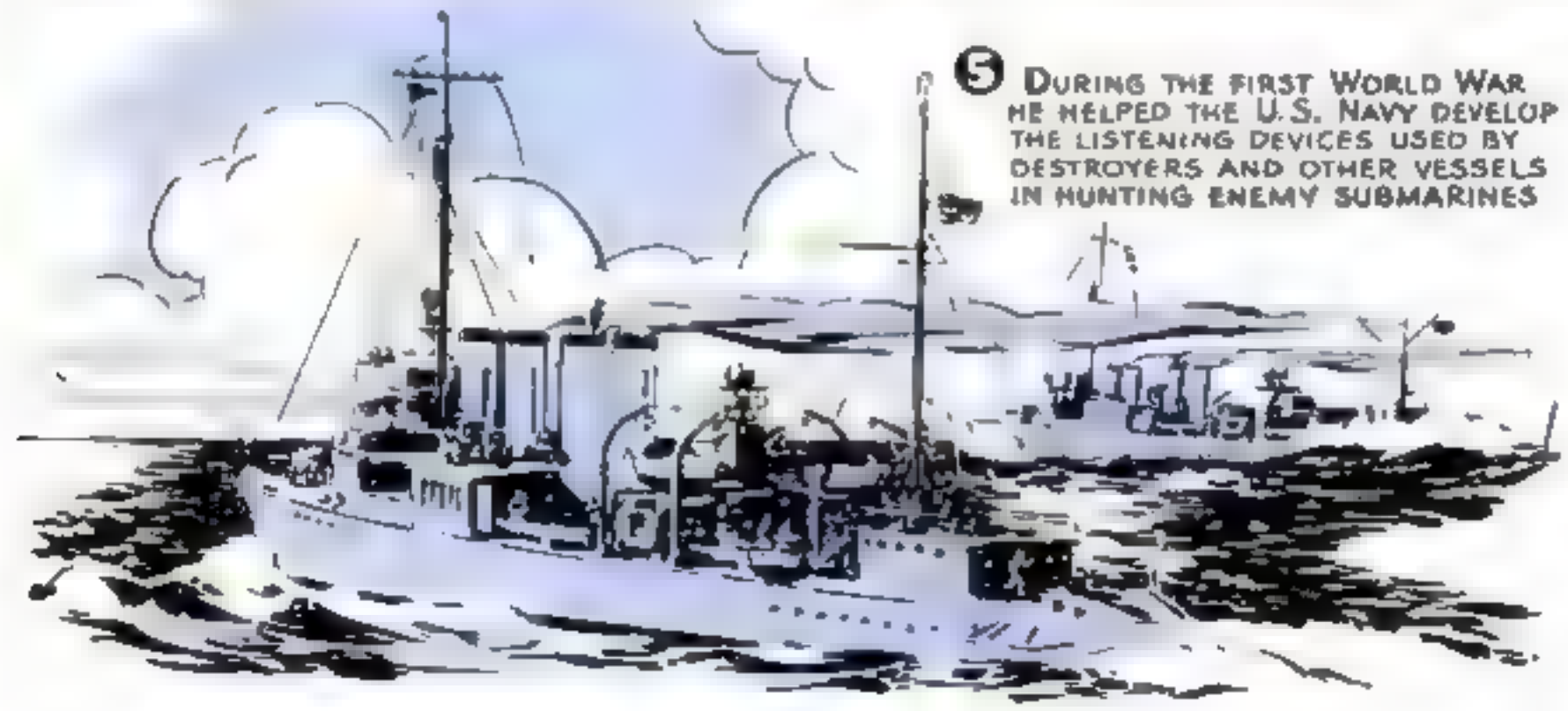
IRVING LANGMUIR'S INTEREST IN SCIENTIFIC RESEARCH GOES BACK TO HIS FIFTEENTH YEAR, WHEN AN OLDER BROTHER TOLD HIM ABOUT THE DISCOVERY OF ARGON

HE WAS GRADUATED FROM COLUMBIA UNIVERSITY IN 1903 AND THEN WENT ABROAD TO CONTINUE HIS STUDIES



HE JOINED THE GENERAL ELECTRIC COMPANY IN 1909, AND IS NOW ASSOCIATE DIRECTOR OF THE COMPANY'S RESEARCH LABORATORY

THERE HE DEVELOPED THE GAS-FILLED INCANDESCENT LAMP THAT TODAY PROVIDES MUCH OF THE WORLD'S ELECTRIC LIGHT

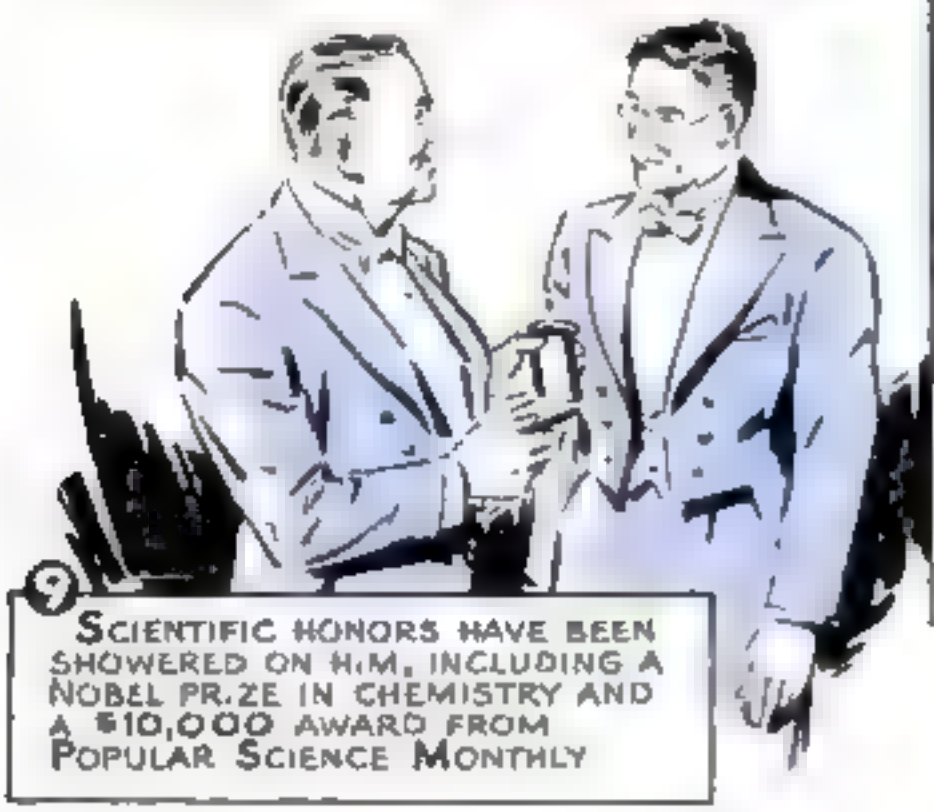


DURING THE FIRST WORLD WAR HE HELPED THE U.S. NAVY DEVELOP THE LISTENING DEVICES USED BY DESTROYERS AND OTHER VESSELS IN HUNTING ENEMY SUBMARINES

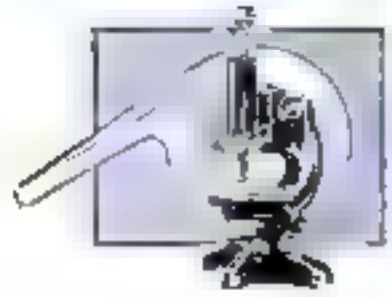
THE CAREER OF DR. IRVING LANGMUIR

RADIO TUBES INVOLVING DR. LANGMUIR'S PATENTS WERE THE SUBJECT OF A 12-YEAR LEGAL BATTLE, WHICH HIS COMPANY FINALLY WON IN 1926

"INVISIBLE" GLASS, WHICH ELIMINATES REFLECTED GLARE, IS ANOTHER IMPORTANT DEVELOPMENT BASED ON DR. LANGMUIR'S WORK



SCIENTIFIC HONORS HAVE BEEN SHOWERED ON HIM, INCLUDING A NOBEL PRIZE IN CHEMISTRY AND A $10,000 AWARD FROM POPULAR SCIENCE MONTHLY



THE FOLLOWING YEAR HE PERFECTED AN IMPROVED METHOD OF ARC WELDING WITH ATOMIC HYDROGEN, ON WHICH HE HAD BEEN WORKING FOR MANY YEARS

TODAY, AT 60, DR. LANGMUIR HOLDS MORE THAN 65 PATENTS ON USES OF ELECTRICITY. ONE OF HIS RECENT INVENTIONS SIMPLIFIES PHOTOGRAPHING X-RAY IMAGES ON FLUORESCENT SCREENS

Dog Fighting—

Flying a Fighter Plane Is Just the Beginning of the Pursuit Pilot's Training . . . Now He Must Learn Gunnery and Tactics

The Curtiss P-40, American counterpart of Britain's Spitfire and Hurricane, Germany's Messerschmitt

ON OUR COVER *is one of the newest pursuit planes — the gull-winged Vought-Sikorsky fighter XF4U-1 now being put through its paces by the U. S. Army Air Corps. Painting by John T. McCoy, Jr.*

THIS is an article about dogfighting and pursuit gunnery, but there is no use talking about fighter planes and their tactics without visualizing the kids who fly them. A pursuit plane is nothing until it is fused with the personality of a scrappy, cocky youngster whose skill is sharpened and kept to a razor edge. Rush Howard Willard, from Bay City, Mich., is a good indication of what is involved when America tries quickly to set up a strong air force.

Rush Willard is 22. He first had his hands on an airplane stick at the age of six, when his legs were too short to reach the rudder controls. At 16 he was flying solo, and about that same time he and a friend built themselves a plane, out of salvage from several wrecks. The inspectors would not give them a license, but they hopped it over a few fences, just to prove it would fly, then made it into an ice boat.

Rush probably would be graduating this June from engineering school if he had not, in the fall of 1939, attained his greatest ambition. He was appointed a flying cadet in the U. S. Army Air Corps. Out of a batch of 20 applicants, he was the only one to pass the physical exam. Out of a primary training class of 56, he was one of 30 who made the grade and won their commissions at Kelly Field last September, after nine months of intensive training.

Now that he had won his wings, Second Lieutenant Willard still had a great deal to learn about flying. Assigned to the 33rd Pursuit Squadron, he spent the next three months in the exciting process of mastering a tactical airplane, a fast, powerful, single-seat Curtiss P-40.

By the time I met him, in late winter, he was a precision pilot, a good formation flyer, and in the regular morning rat race he could throw his plane around with the best of them. He was now ready to *begin* learning to be a fighter.

Pursuit pilots at Mitchel Field, wearing the oxygen masks they use in high-altitude flying. Fighter-plane engines are designed to operate best in the rarefied upper air

To most of us, the mere flying of a plane is an accomplishment far beyond our expectations. Young Willard was already an aviator before he enlisted as a cadet, and that gave him about as much head start over his classmates as a child has who learns to read before he goes to school. Only by a few flying hours, for instance, did he have any advantage over the other 99 percent of cadets—like his roommate, Lieutenant Max McNeil, from Raymond, Wash., who had been in a plane only once before he became a cadet.

Willard was one of the youngsters breaking in as a pursuit flyer at Mitchel Field, Long Island, under the tutelage of Lieutenant Phil Cochran, of whom I told last month. While I waited for a chance to talk more with Cochran, I sat around getting acquainted with the kids.

"You know, it was POPULAR SCIENCE that got me started in this," said Max, when I told why I was asking so many questions. "I read an article on Army flying, which got me all excited. I was a sophomore at Washington State College in 1939 when the flying board came around giving exams,

and I remembered that article and joined up."

"That's funny," said Rush. "I read that same article, and after that there wasn't anything I cared about but getting in the Air Corps. I took a physical exam every six months to be sure I'd be able to pass." Rush went two years to Bay City Junior College, to qualify for the Air Corps mental standards. He earned his way by leading a 12-piece dance band.

* * *

Phil Cochran looked out of his cockpit at Rush Willard, who was close beside him in echelon right. Phil held up his right fist, shook it beside the glass pane of the canopy. Rush held up his left fist and shook it back. A challenge had been accepted.

The pair cut out of formation and swung off where there was plenty of room. They separated, then drove at each other head on, at top speed, passing close. At the instant of passing, the fight was on. Now it was a question which could turn the quickest, without losing speed.

Back in the World War days, flyers lived in an age of invention. The man who could discover a new trick became an ace, because he took his opponents by surprise. Nowadays it is about as easy to invent some new way of throwing a plane around as it would be for Joe Louis to produce a blow brand-new to boxing. The pursuit flyer has to learn all the tricks, as part of his elementary knowledge. But he depends on his turn, as a fighter depends on his left.

A pursuit plane fires only in the direction in which it flies. The flyer does not aim his guns, he aims his plane. Also, it is virtually impossible to shoot down a fighter plane from the side, because it is moving too fast. Therefore the dogfighter has two objectives: to get on the tail of his opponent, and to keep the opponent off his own tail. Only from the tail can he get a good shot. The quick turn is the means of accomplishing both these ends. That is what they mean by maneuverability.

A plane built primarily for speed has small wings, a high wing load. In turning, banked vertically against centrifugal force, such a plane will "mush," as an automobile skids; and this slows up its turns. That is one reason the British planes, with lower wing load, have done so well against the fast Messerschmitts. In a close turn, a Messerschmitt stalls.

There has been some controversy about the relative qualities of American and European fighter planes; it has been said that the Messerschmitts can run away from anything America produces. I didn't discuss this with Phil Cochran, and certainly he wouldn't want to get mixed up in any controversy. But it is interesting to consider his fighting philosophy, which he is imparting to the youngsters.

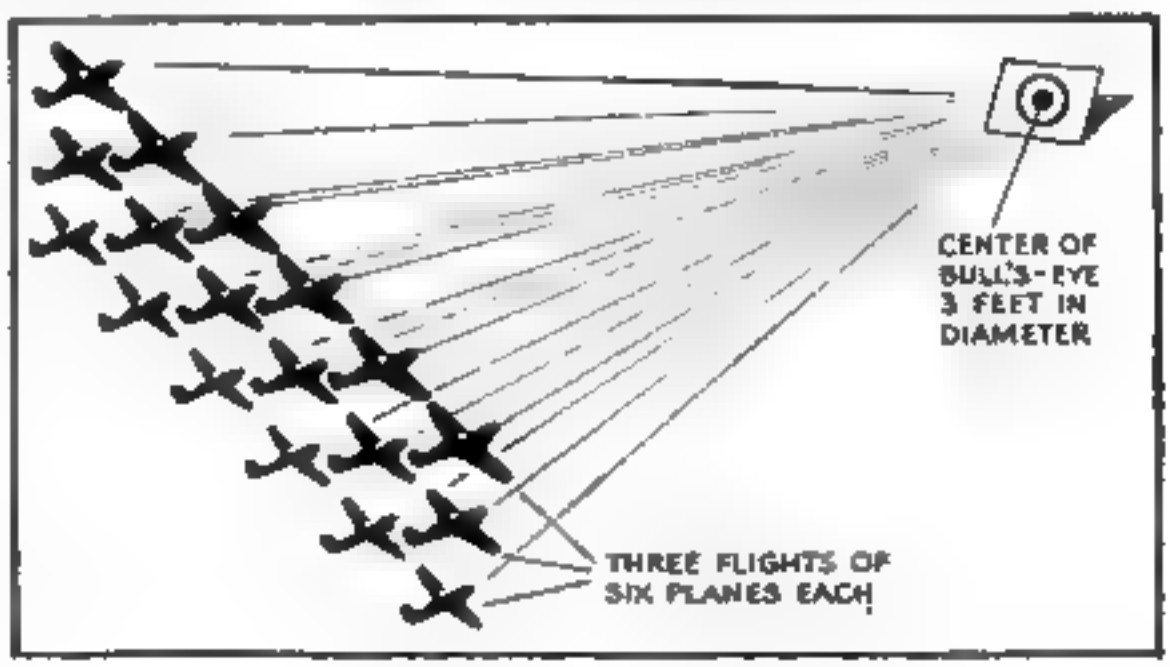
Phil doesn't figure he is going to want to run away, or that his opponent will want to, either. He will be trying to get at a bomber, while his opponent will be trying to protect the bomber, and the two of them will stay right there and fight it out. In such a finish fight he wants to be able to excel in the turns.

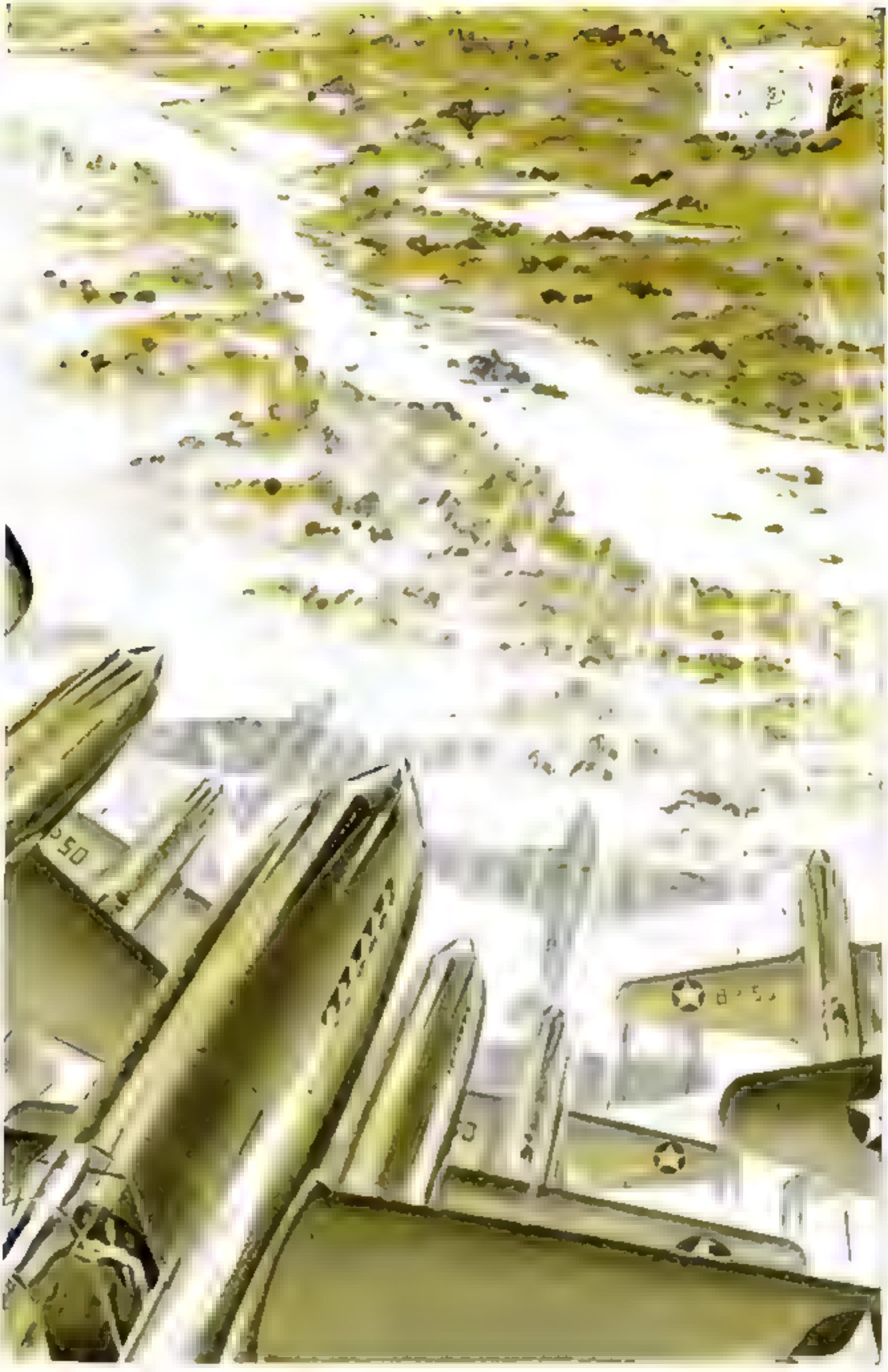
"The guy that can turn inside the other will win," he tells the kids. So they practice turns, drawing them tighter and tighter, fighting against each other. If the turn is too tight, then the plane stalls—that is, it loses speed and starts to fall. The idea is to pull the turn up just to the point of maximum effectiveness. And of course, in any turn worthy of the name, the flyer blacks out; centrifugal force drives the blood from his head and he goes unconscious for an instant. He has to go on flying his turn precisely, while semiconscious. It takes not only skill, but constant practice.

Chasing tails this way, one plane often wants to duck away. A dive is bad, for though speedy it loses altitude, the fighter's great advantage. One helpful trick is to dodge into a cloud. The unwary pursuer will follow, but the wise one will climb above the cloud and wait for his quarry to reappear, then dive on him. Another trick is to climb straight into the blinding sun, and thus to lose the plane behind.

Working in all three dimensions, planes

"Sandwich fire," the breath-taking maneuver in which a whole squadron of 18 planes concentrates all its guns on one target is a curtain of machine-gun fire





This black panther is the insignia of the 35th Pursuit Squadron. Each of the three flights in a squadron has a commander, whose plane is marked with distinctive stripes to guide the other planes in taking their positions. Squadrons have different colors for noses, stripes, and wheels, and each plane carries its squadron insignia. A grim humor is often displayed in designing these symbols

do not merely make horizontal turns. A pull back on the stick brings the plane up sharp into the start of a loop, which is a vertical turn. But Phil Cochran tells the kids that the loop is a silly maneuver. Speed is lost. There is a good chance the following plane can turn inside, and in any case he can probably draw the loop just as tight, so there is nothing to be gained.

There is another turn, though, used when a pursuer is close behind. The pilot draws himself up close and tense, then shoves the stick hard forward. The plane noses down and under. With a terrific jolt, the wing load reverses. The sudden reverse strain, of seven or eight gravities, would tear anything but the best plane apart. The flyer's safety belt is strained to the utmost. He'd better have his neck pulled in, or he will crack his head on the canopy above it. No black-out this time, for the blood all rushes to the head. It is very uncomfortable.

It is especially uncomfortable for the flyer following, for he hasn't been expecting it and hasn't had a chance to get set. It is embarrassing too, for in doubling under the leading plane goes into the blind spot underneath its pursuer, and for the time being cannot be seen.

After Phil Cochran told me about this violent maneuver, I was talking about it to another flying officer.

"Oh, yes," he said. "That's one they say the Messerschmitts use to get away from Spitfires. The German planes have fuel injectors, which are not affected by the reversal of gravity. But the Spitfire has a carburetor. When it reverses, the carburetor float control pulls up, and the engine dies for a moment."

Thus the fighter pilot feels for, and uses, the weaknesses of his adversary.

* * *

Fighter planes move so fast that, when a plane does manage to get on the enemy's tail, the pilot must fire on the split second. And he must aim, with microscopic accuracy, at a plane which may be traveling more than 300 miles per hour. There is no use for a pilot even to start gunnery practice until he can fly with the utmost precision.

Rush Willard and his contemporaries were ready, this spring, to take the ground gunnery course—known, from its Army regulations number, as "Four-forty dash forty." For this course the pilot goes to a gunnery camp and spends three weeks.

Stretched across the range is a row of six targets, enough for one flight to use at a time. Each target is ten feet wide, six feet high, and is set at an angle of 60 degrees on the ground. The bull's-eye is three feet in diameter, and there are two rings around it.

After a certain amount of preliminary work, the gunner starts making his runs for score. One of his four guns is loaded with 50 rounds. Diving on his target, his eye glued to his sight, he must not fire until he has passed the marker for a range of 500 feet. Then a light touch on the trigger, which is on the handle of his stick. There is time for no more than four or five shots before he has to pull out of his dive. He has ten dives in which to fire a run of 50 rounds. Then he lands to reload and the score is counted up. A hit on the bull's-eye counts 5, the next circle 4, the next 3,

Flyers receive assignments for duty in this busy operations office. The skill of a fighter pilot is acquired only by constant practice, and it takes more of the same thing to keep it

and a hit on the target outside the circles is worth two. The possible score is 250. If a man is really good he will shoot around 230.

To make an official score in '440-40, the flyer makes two runs at 500 feet, two runs at 700 feet, and two runs at 1,000 feet, from right and left-hand approaches.

The good marksman does not merely aim at the target, he aims for 5, 6 or 7 o'clock on the bull's-eye. In a cross wind he has to allow for crab, a sideways motion of his plane. He has to have his wings precisely level when on the target. The several guns on the plane are set, of course, to converge on a small pattern at a selected range. But when the plane is tilted a variable factor enters. A bullet does not fly straight; its trajectory is an arc, vertical to the earth. The trajectory does not tilt with the plane. Lift a wing and your guns are out.

After making his score on the ground targets, the pilot must shoot at a moving target. This is a tow target which is attached to the end of a cable that extends several hundred feet behind the bomber that is flying it. The pilot has four runs of 50 bullets, and each hole in the sock counts one point. Several gunners fire on the same sock.

Dogfighting and rat-racing are not the only subjects in the curriculum. Here some of the boys are brushing up on dots and dashes for radio work

Ready to take off. Note radio headphones and jack cords

but each has his bullets painted on the tip with a distinctive color. The bullet which hits leaves a telltale trace of paint around its hole.

There are three ratings for men who have taken this gunnery course: Expert, Sharpshooter, and Marksman. To remain a pursuit pilot, a flyer must rate as Expert.

Ground gunnery, of course, is only an introduction to aviation marksmanship. The pursuit pilot must fire at moving objects, and providing a counterpart for actual combat shooting has always been a problem. For a while the Army used camera guns, but these proved to be inaccurate, for light travels to a camera faster than a bullet goes to its objective. Like a duck hunter, the pursuit pilot always has to take a lead. Today the British are using cameras in their planes to record the effect of combat marksmanship on strips of motion-picture film. But for practice something else had to be found.

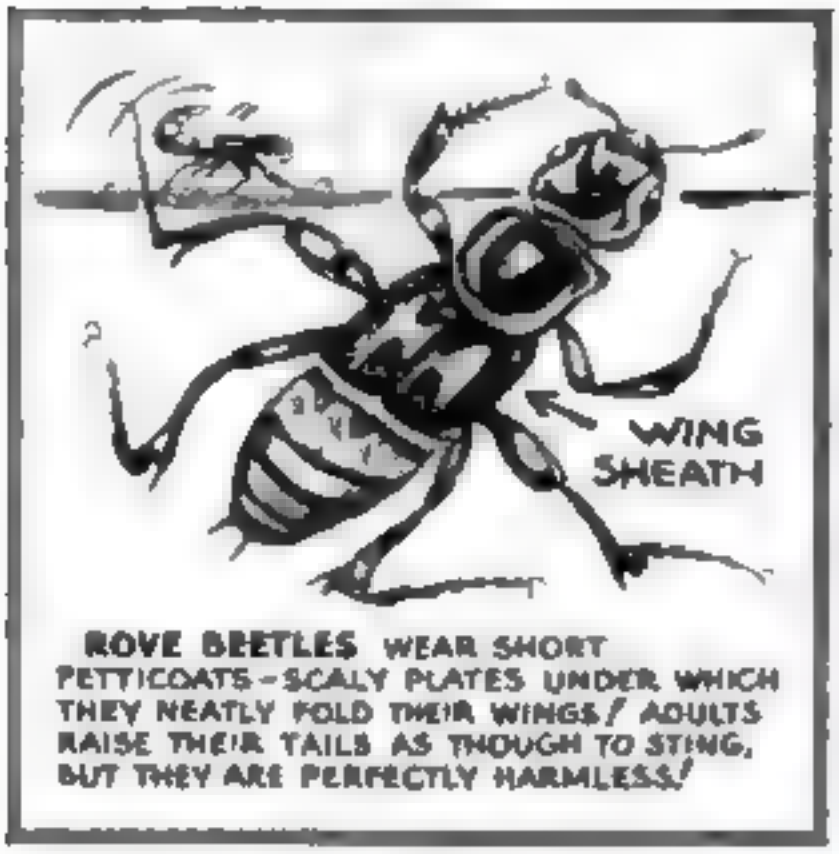
One method the Air Corps now uses is to fly a plane over water in bright sunlight. The shadow on the water then becomes the target. Diving on the moving shadow, the gunner can determine just how accurate his fire is, by watching the splashes.

A pursuit squadron is supposed to have 25 planes, with three extra pilots. But in the air its strength is 18 planes in three flights of six, unless the squadron commander chooses to fly separately as a nineteenth. Each flight commander's plane has a stripe marking; each squadron has a distinctive color for the nose, stripes, and wheels of its *(Continued on page 220)*

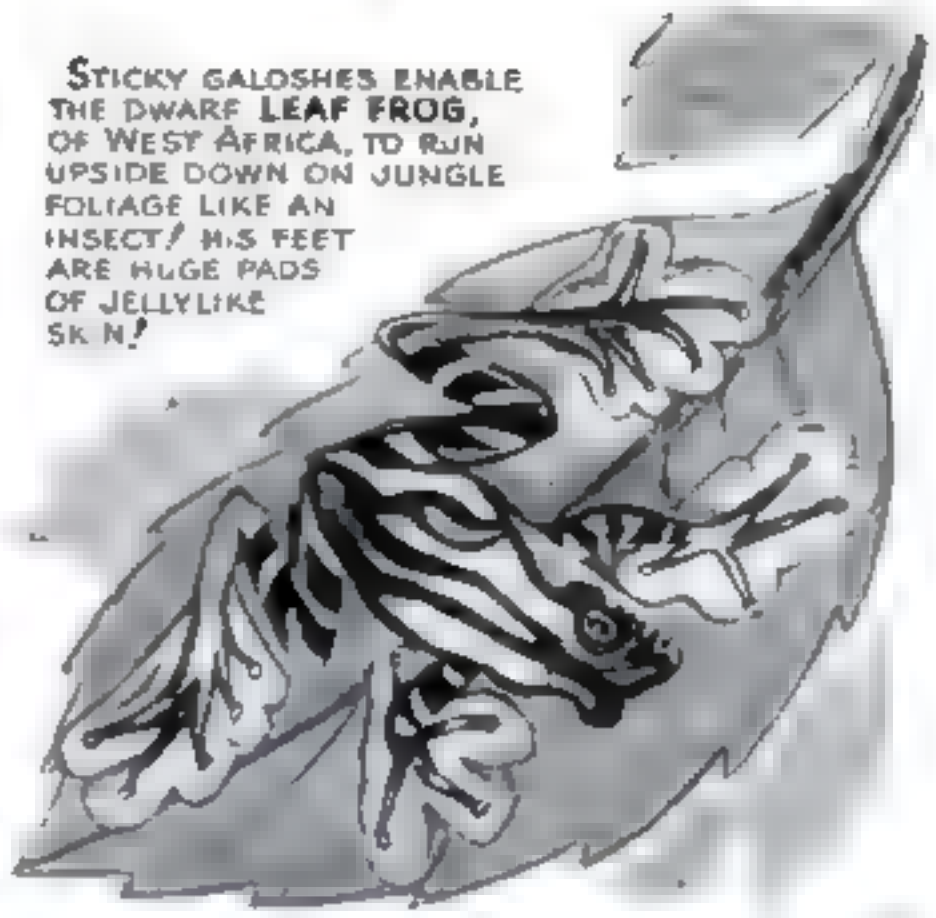
It isn't all work, however. A pilot shows pictures of his early flying days—or the girl back home

Un-Natural History

BY Gus Mager

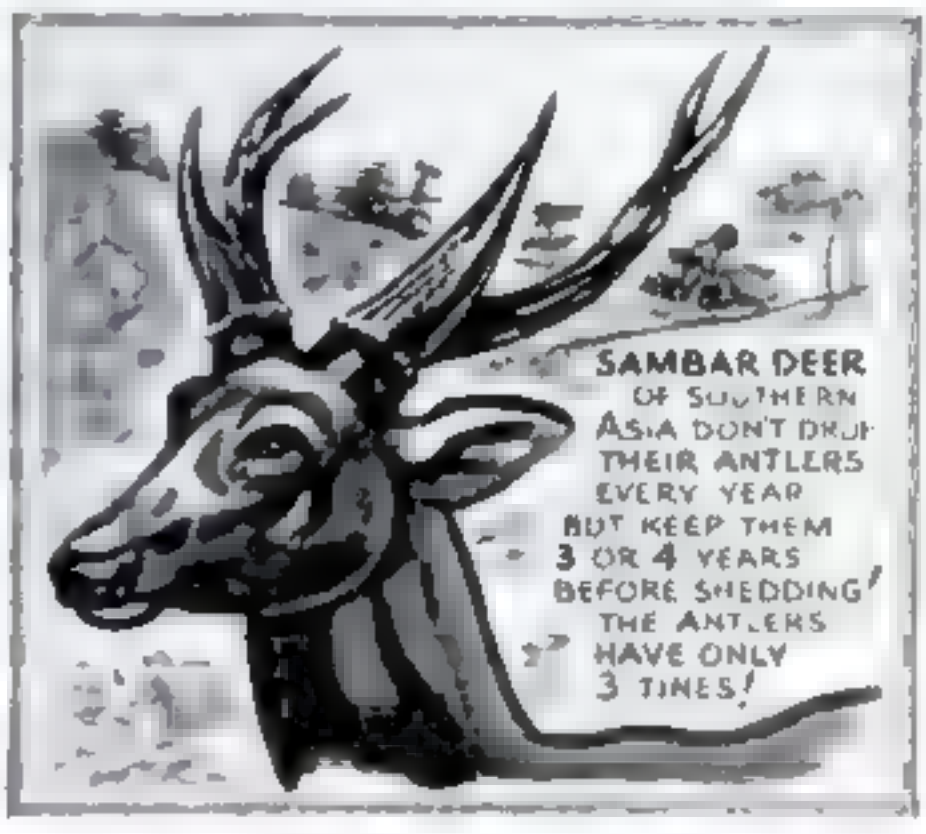


ROVE BEETLES WEAR SHORT PETTICOATS—SCALY PLATES UNDER WHICH THEY NEATLY FOLD THEIR WINGS! ADULTS RAISE THEIR TAILS AS THOUGH TO STING, BUT THEY ARE PERFECTLY HARMLESS!



STICKY GALOSHES ENABLE THE DWARF **LEAF FROG**, OF WEST AFRICA, TO RUN UPSIDE DOWN ON JUNGLE FOLIAGE LIKE AN INSECT! HIS FEET ARE HUGE PADS OF JELLYLIKE SKIN!

WHILE THE **SKUNK'S** POWERFUL ODOR BATTERY SEEMS PLAINLY A DEFENSIVE WEAPON, THE TINY **MUSK DEER** OF NORTHERN INDIA HAS AN EQUALLY STRONG BUT FRAGRANT ABDOMINAL SAC WHICH SUPPLIES THE BASE OF FINE PERFUMES!



SAMBAR DEER OF SOUTHERN ASIA DON'T DROP THEIR ANTLERS EVERY YEAR BUT KEEP THEM 3 OR 4 YEARS BEFORE SHEDDING! THE ANTLERS HAVE ONLY 3 TINES!

THE KNIFE-TOOTHED **RIBBON FISH** A SERPENTINE DEEP-SEA MONSTER SOMETIMES 20 FEET LONG, IS OCCASIONALLY SEEN FLOATING NEAR THE SHORE! SOME SCIENTISTS BELIEVE IT IS THE ONLY AND ORIGINAL SEA SERPENT!

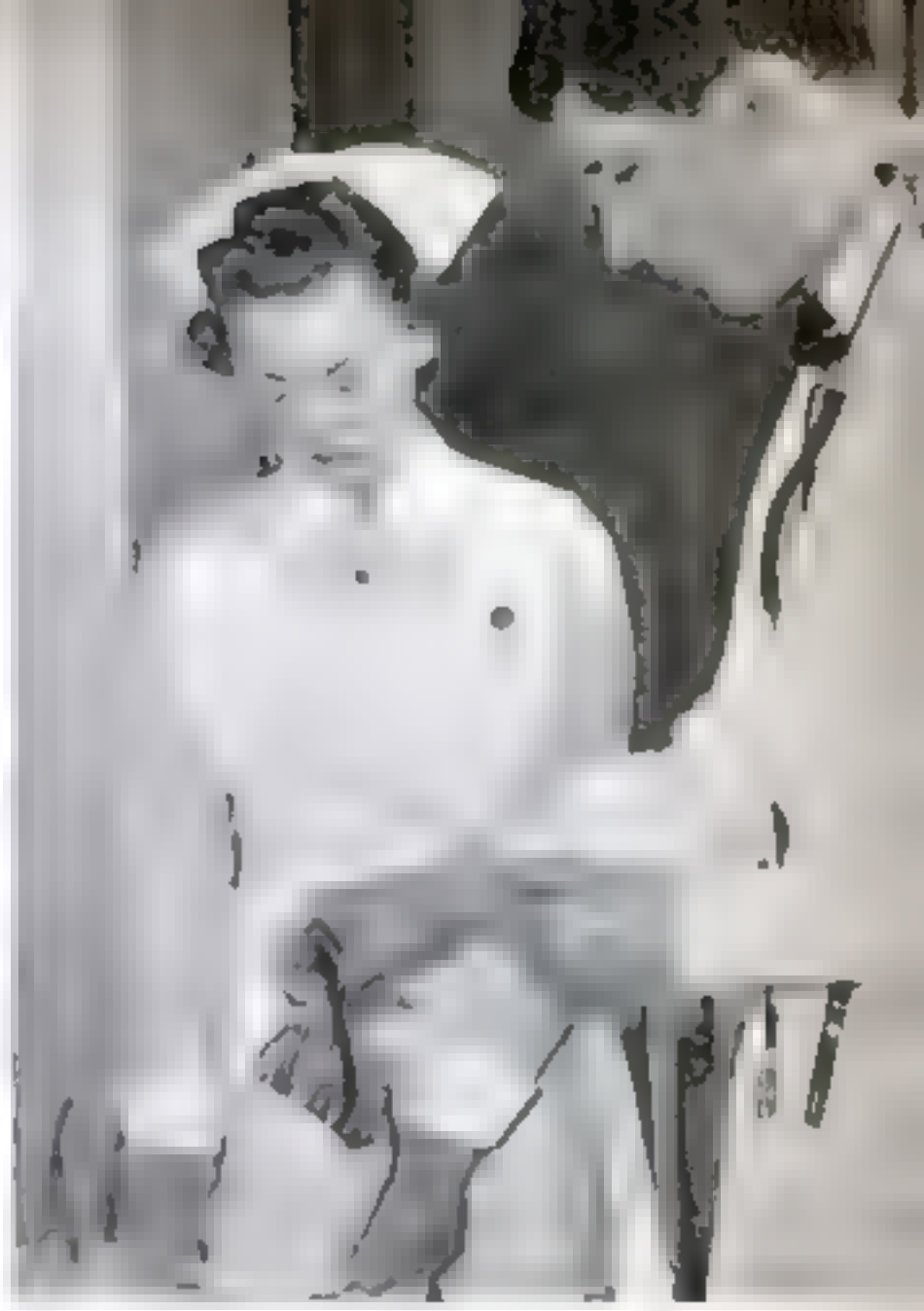
ALTHOUGH THE PINT-SIZE **FENNEC FOX** GROWS TO BE ONLY ABOUT 15 INCHES LONG—OF WHICH HIS TAIL IS 7 INCHES—HE SPORTS THE LARGEST EARS OF ALL THE FOXES! THEY ARE STUFFED WITH HAIR TO KEEP OUT DESERT SAND!

Photo by Robert Smith

AMERICA STORES BLOOD for emergencies

TO MEET defense needs, and for use in emergencies, the American Red Cross is preparing the largest reservoir of blood plasma in the nation's history. It will contain 10,000 units of dried plasma, equal to 10,000 pints of blood. The campaign for blood for Britain proved that dried plasma, which can be kept for five years, is the best known form in which to store material for transfusions. Pictures on the following pages show how it is prepared.

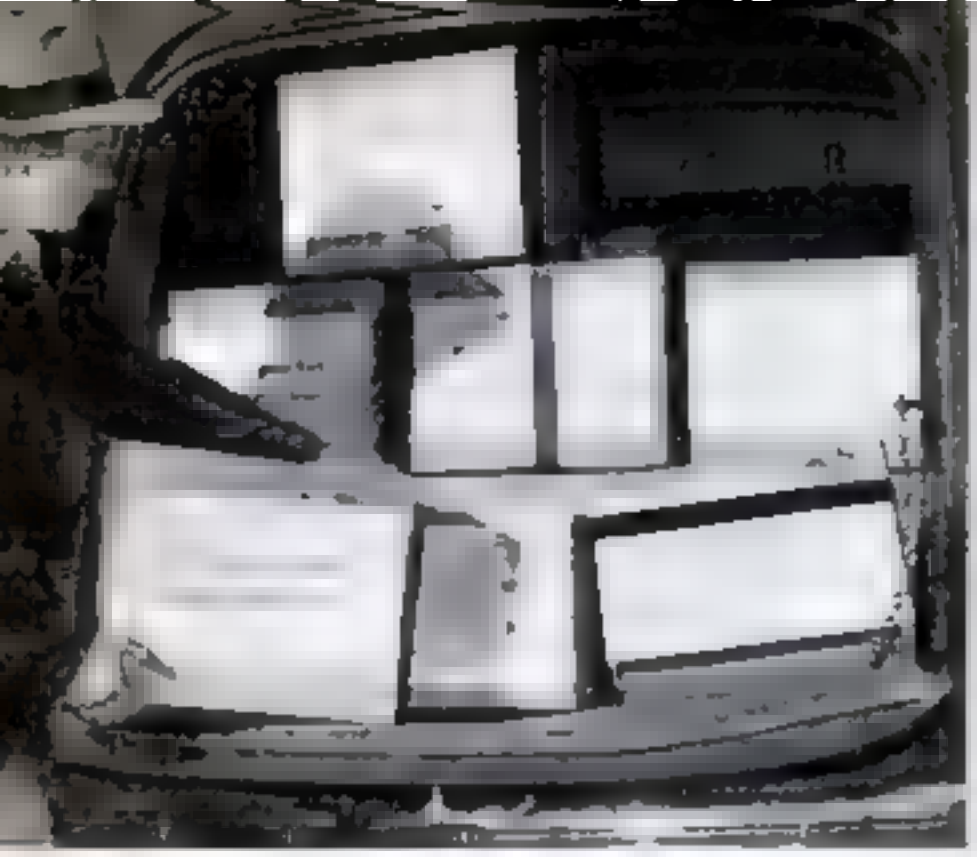
1 At the Presbyterian Hospital in New York City Nurse Vivian Bradshaw prepares a donor's arm for phlebotomy, or extraction of blood. Five hundred cubic centimeters are taken from each donor



2 Dr. Earl Taylor, wearing rubber gloves, removes the collecting bottle from the sterile canvas sack in which it was shipped to the hospital from the laboratory near Philadelphia, Pa

3 While the nurse operates a hand pump which exhausts the air from the bottle to permit free flowing, blood passes through a tube leading from the intravenous needle puncture into the bottle

4 When filled the collecting bottle is tagged with the donor's name and stored in a large refrigerator with other bottles awaiting shipment to the laboratory for preparation [CONTINUED]



5 At the Sharp & Dohme Laboratories, cartons of blood are unloaded from a truck. Each of these cartons contains six collecting bottles

6 Norris Harrington removing a collecting bottle from its canvas sack. This is done in a room kept constantly at a temperature of 34° F.

7 The collecting bottle is placed in a centrifuge. Made of armor plate ⅜ of an inch thick, this machine has a speed of 2,500 r.p.m.

8 When the bottle is removed from the centrifuge, the blood plasma is at the top, and the red and solid material rests at the bottom

9 Bottles of separated blood now go to the "pooling room," where the plasma is drawn off the top of each into a large glass cylinder

10 Plasma is tried out on animals to see if it has any toxic effect. Dr. J. E. Schneider holds a guinea pig while C. H. Barr injects plasma

11 Technician Richard Hardcastle examines an ampule of blood plasma before freezing, to make sure that it does not contain any foreign matter

12 For the "shelling" process an ampule of plasma is placed on a geared spindle which rotates it in a trough in a bath of dry ice

13 Vacuum pumping for 72 hours in this dehydrating machine removes water from plasma leaving a dry flaky powder containing all other elements

14 The dehydrated plasma is corked under vacuum and the neck of the glass ampule is sealed by holding it in jets of flaming gas

15 After labeling, the plasma is stored. It will remain stable for an indefinite time. Neither arctic cold nor the heat of the tropics affects it

16 Dr. De Kruine of the American Red Cross examines a bottle of plasma stored in a refrigerated vault ready for use in emergency

This tower cools water for liquefying natural gas

Gas on Ice

Storage Plant Shrinks Fuel to 1/600 Its Normal Volume as Reserve for Emergencies

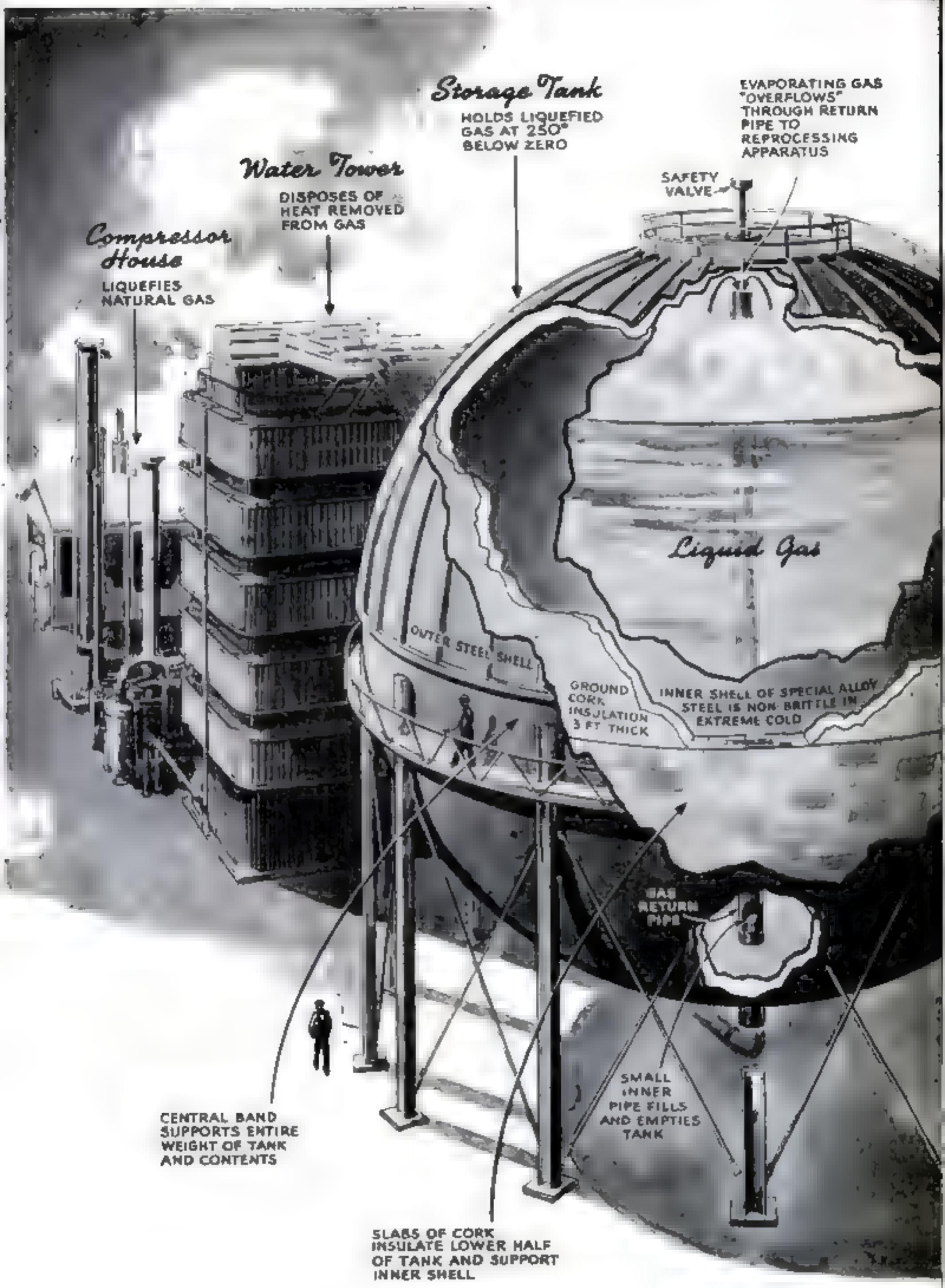
LIQUEFYING natural gas by chilling it to 250 degrees below zero, and storing it in three big globular "ice boxes," has solved the problem of providing reserve fuel for customers of the East Ohio Gas Company, in Cleveland and other Ohio cities.

When thousands of patrons meet a cold snap by turning on their gas heaters, all at once, the sudden demand quickly empties ordinary gas tanks. Even the common expedient of compressing gas in miles of pipe lines, to the limit of safety, has failed to bridge a spell of below-zero weather. The new scheme of liquefying the gas shrinks it to only 1/600 of its normal volume, permitting an adequate supply to be kept ready.

Piped from a West Virginia field 150 miles away, the gas is refrigerated in turn with ammonia and ethylene, transforming 4,000,000 cubic feet daily into a super-cold fluid that looks like soda water. It fizzes and gives off curling "smoke." Pipes deliver it to spherical, cork-insulated tanks, each 63 feet in outside diameter. When needed, the liquid is drawn again through tubes surrounded by live steam, which regasify it at a rate of 3,000,000 cubic feet an hour. During late fall months, when demand is low, the gas will be stored up for winter use.

Because moisture would turn to ice, and carbon dioxide to "dry ice," clogging the piping, both are removed from the gas before refrigeration. A special steel alloy forms the inner shell of each tank, since the extreme cold would render ordinary steel brittle enough to shatter at the tap of a hammer.

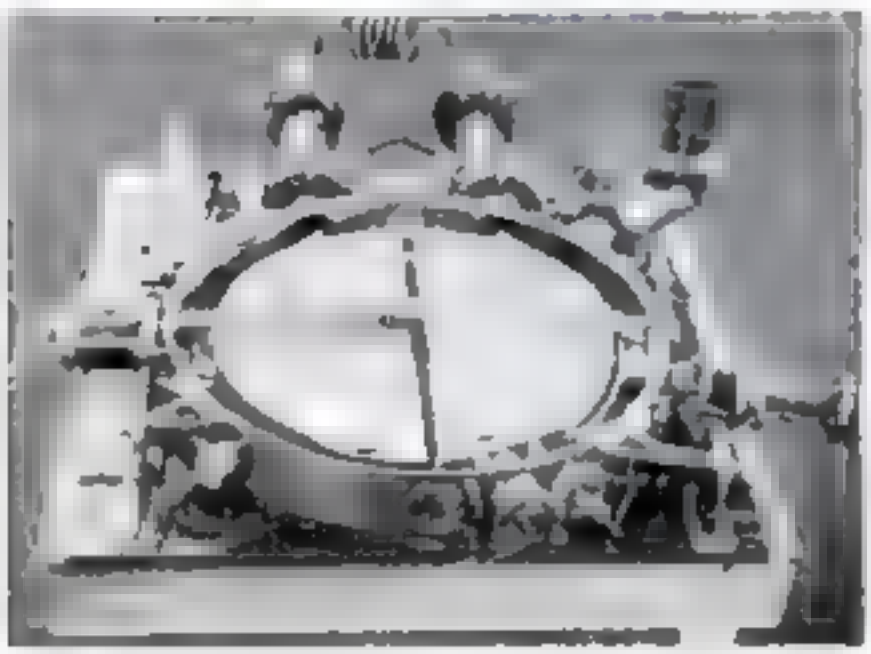
The old and the new in gas storage. The conventional tank in the background holds 2,000,000 cubic feet of gas; the smaller spherical tank holds liquefied fuel equal to 50,000,000 cubic feet of free gas. Between them are the refrigerating tower and liquefying plant of the newer system


Storage Tank
HOLDS LIQUEFIED GAS AT 250° BELOW ZERO
EVAPORATING GAS "OVERFLOWS" THROUGH RETURN PIPE TO REPROCESSING APPARATUS
Water Tower
DISPOSES OF HEAT REMOVED FROM GAS
Compressor House
LIQUEFIES NATURAL GAS
SAFETY VALVE
Liquid Gas
OUTER STEEL SHELL
GROUND CORK INSULATION 3 FT THICK
INNER SHELL OF SPECIAL ALLOY STEEL IS NON-BRITTLE IN EXTREME COLD
GAS RETURN PIPE
SMALL INNER PIPE FILLS AND EMPTIES TANK
CENTRAL BAND SUPPORTS ENTIRE WEIGHT OF TANK AND CONTENTS
SLABS OF CORK INSULATE LOWER HALF OF TANK AND SUPPORT INNER SHELL

WHAT IS IT

A QUESTION BEE IN PHOTOGRAPHS

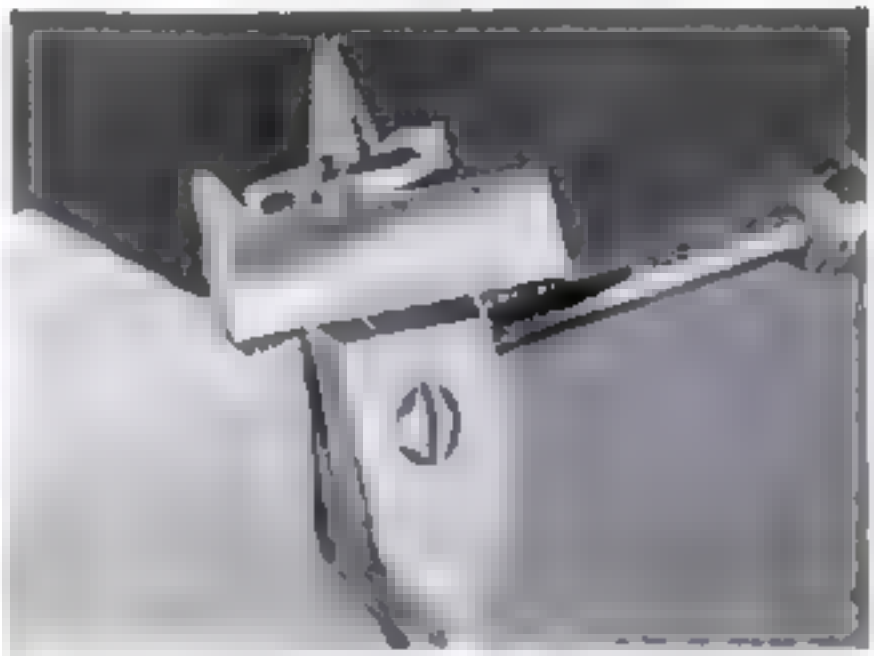
Usually we tell you what's what in our pictures; this time you tell us. Try to identify the objects in the photographs, from the hints given. Turn to page 222 for the answers and see how you fared.



1 A queer-looking thing, isn't it? Possibly it's a *radio transmitter*, or a *cyclotron*. But on the other hand, are you sure that it isn't a *seismograph* or a *dynamometer*?

2 The weather man distinguishes between different kinds of clouds, such as *cumulus*, *nimbus*, and *cirrus*. Can you tell which of these kinds is illustrated above?

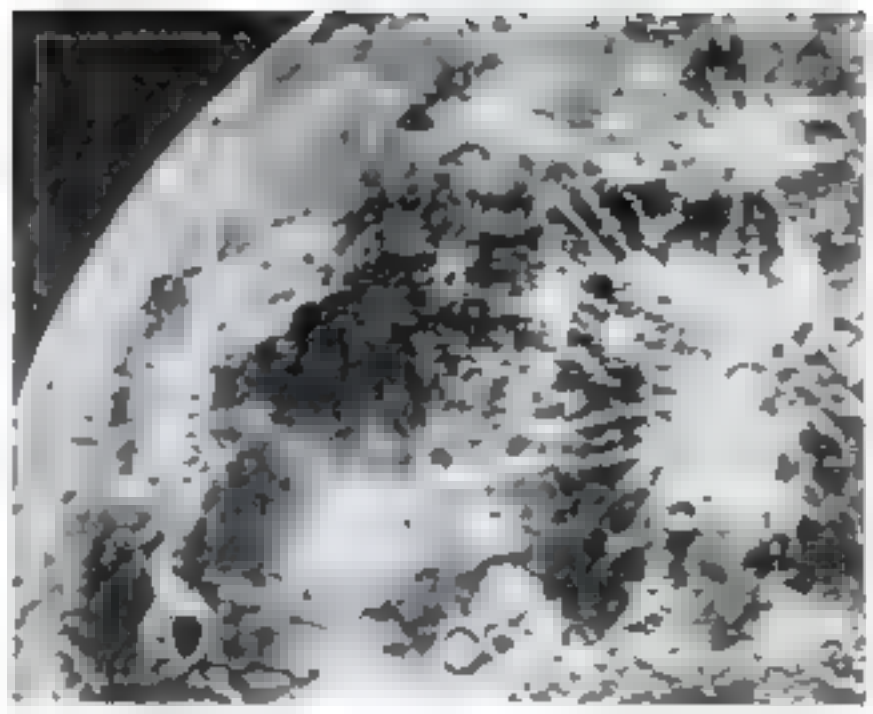
3 Airplane motors have to be kept from overheating. Here is a mighty radial engine of 2,000 horsepower. Is it cooled by air? Water? Gasoline? Chemicals?



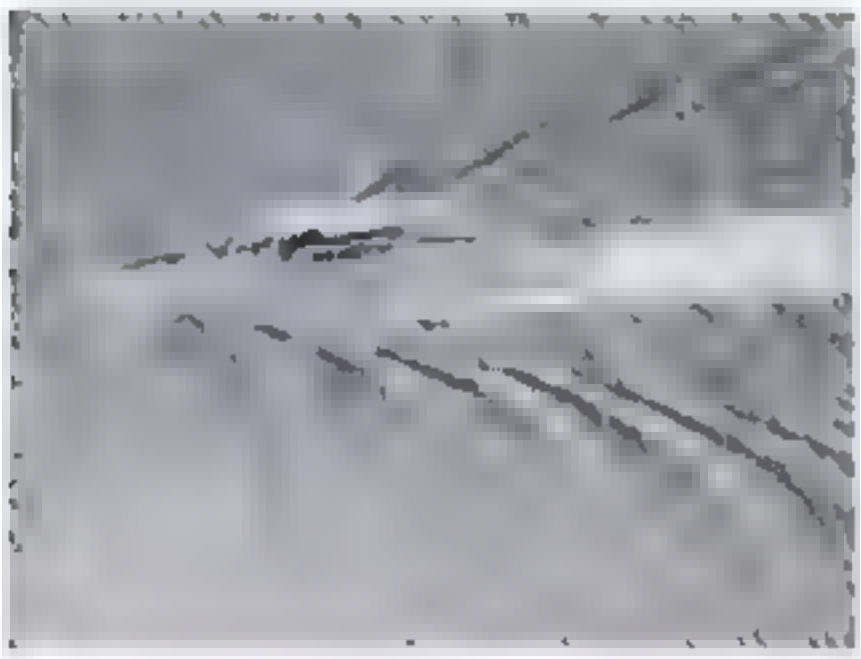
4 For boring holes in wood, this tool often comes in handy. Maybe it's a *gimlet bit*—but then again, it might be an *expansive bit*, or, perhaps an *auger bit*.

5 Here's a handy man busily at work with his spokeshave. Wait a minute—perhaps that's wrong and it's really his *saw set*, or *milling cutter*, or *miter box*.

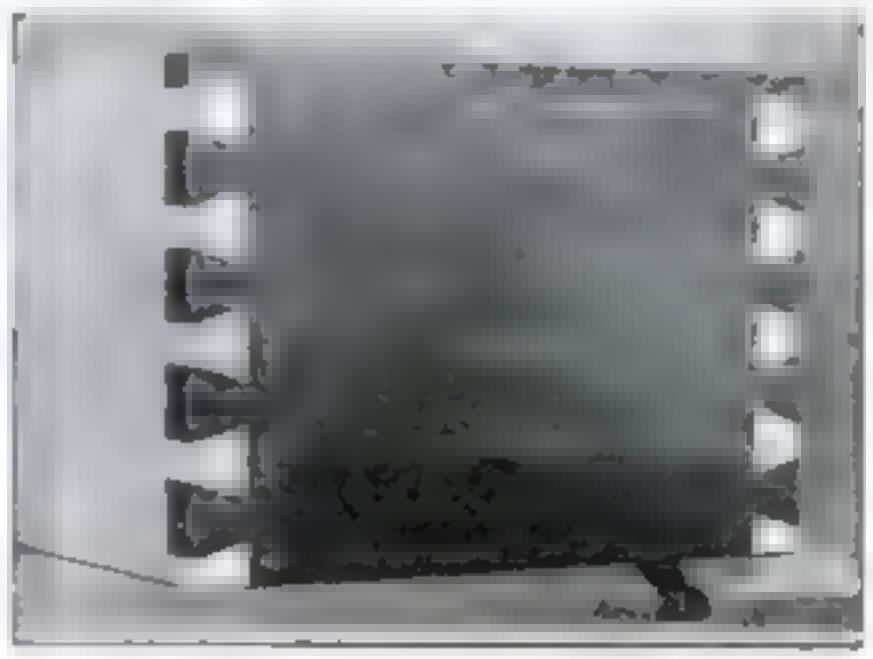
6 Who hasn't seen this handsome butterfly, shown above in reduced size? It's a *Tiger Swallowtail*—no, it's a *Monarch*—or would it be called a *Cabbage Butterfly?*



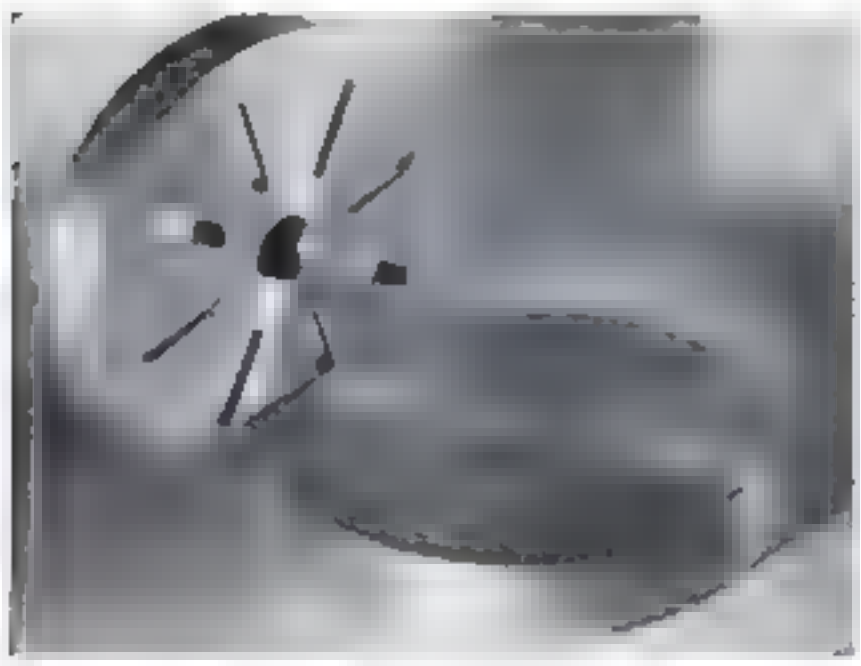
9 Figure out this picture puzzle, if you can. Is it a photograph of *Mars? The sun? The moon?* Or a *European battlefield*, devastated by heavy artillery fire?



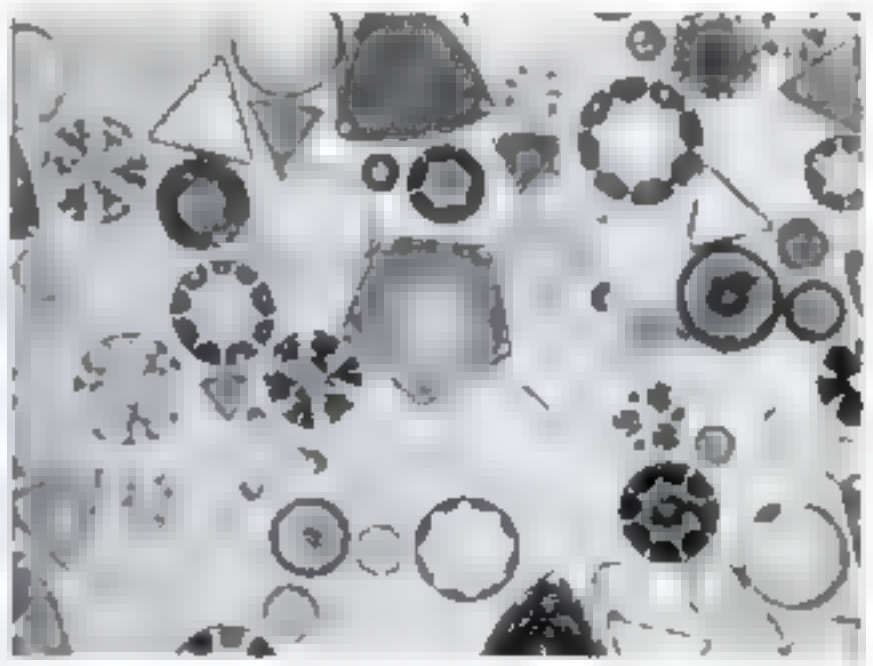
7 From this pilot's-eye view, would you conclude that the U. S. naval vessel in the picture is a *mine layer? A cruiser? An aircraft carrier?* Or a *river gunboat?*



10 *Lap joints* sometimes are used to fasten things together. So are *mortise-and-tenon joints, universal joints,* and *dovetail joints.* Which kind is pictured?



8 Possibly you may imagine that these objects are *drum sanders,* or *roller bearings,* or *lathe face plates,* or improved *hockey pucks.* In one case you'll be right.



11 If you peer into a microscope and see things like this, are you looking at *snowflakes? Diatoms? Bacteria? Algae?* Or a sample of *dust collected from city air?*

Charge of the Iron Brigade

HOW THE MACHINE-TOOL INDUSTRY OF AMERICA STOLE A MARCH ON THE GERMAN HIGH COMMAND

By RAY MILLHOLLAND

SINCE the earliest beginnings of modern warfare, down to the machine gun and 40-mile-an-hour tank, every successful general has won the final verdict with battalions under orders to stay away as far as possible from the firing line. England and France almost forgot that lesson at the beginning of the World War of 1914-1918. They drafted skilled mechanics indiscriminately with other men of military age and rushed them off to the firing lines. And almost too late they attempted to remedy this nearly fatal mistake and withdrew from the front their men skilled in the production of mechanical weapons. By that time Germany, which had kept her skilled mechanics well back of the firing line busily engaged in turning out munitions for her victory-flushed armies, was within arm's reach of a final knockout of her enemies when the United States entered the war. Then and there Germany's doom was sealed

Perhaps no country in history has learned so much from a crushing defeat as Germany learned from hers of 1918. This time she entered the war against France and England with her machine-tool production eight times larger and employing ten times as many skilled mechanics as the one which had failed to insure her victory in 1918.

The dazzling swiftness with which in this new war Germany has crushed every enemy within striking distance of her mechanized army is proof of the overwhelming power of her war-material production machine. Opposed to German tanks and planes by the thousands, England and France could only fight a suicidal rear-guard action with a mere handful of similar weapons.

The truth is that Germany had already won those blitzkrieg battles of Poland and France back in 1934, when she began—openly and without violating the letter of the Treaty of Versailles—to build more machine-tool plants. By 1939 she had increased her machine-tool production capacity by 800 percent. It is significant that Germany did not openly defy her former conquerors by reoccupation of the Rhineland and the open manufacture of guns and planes and tanks until her machine-tool production capacity was overwhelmingly larger than the combined capacity not only of France and England but of the United States as well. And the first direction in which Germany struck after she was ready for war was against Czechoslovakia, the second-largest producer of machine tools on the European continent.

Why did Germany first get her machine-tool production in order before daring to come out openly in violation of the Versailles Treaty and manufacture forbidden military equipment? That is a question far easier to answer than why France and England looked on while their former enemy continued to double her machine-tool capacity year by year without their taking warning and following a similar course. The explanation for Germany's action is that machine tools are the master creative machines of all mechanical goods useful for either peace or war. A lathe can today be innocently employed making a motor for a housewife's vacuum cleaner and tomorrow can be converted into a machine for making parts for a Stuka dive-bomber motor. In fact, with an elaborate plan of secretly prepared special gauges and tools, such a lathe can be transformed from a peacetime operation to war work in an hour or less.

That is exactly what Germany planned to do from the very start when she began expanding her machine-tool building capacity. She was preparing for M-day, when countless thousands of lathes and drill presses, and other seemingly innocent machines working on automobile parts and cream separators and vacuum cleaners, could be switched over to war production between sunset and sunrise. Proof of this lies in the fact that, prior to 1934, while Germany was suspected of doing some bootleg manufacture of war planes and tanks, neither France nor England considered the volume of this illegal production to be a serious menace.

From 1936 on, however, disturbing rumors became current that Germany was rearming at an amazing rate. By 1938 competent and disinterested aviation experts were declaring that Germany had the largest air fleet of superior fighting planes of any nation on earth, larger than the combined fleets of France and England. Then,

Machine tools can reproduce themselves: A turret lathe turning out pinion gears to be used as parts for similar turret lathes

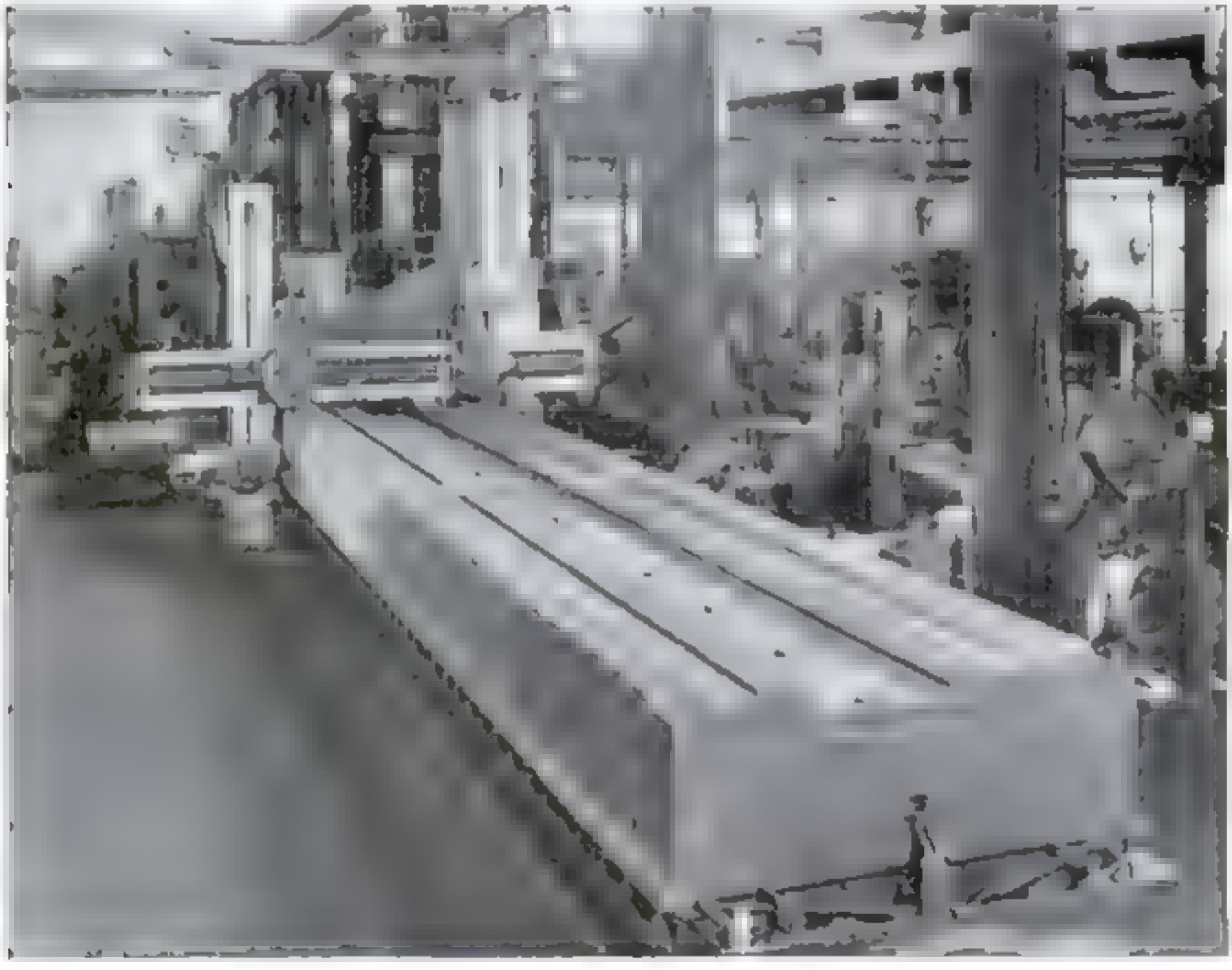
there were further rumors that tanks and mechanized artillery units were pouring from her factories in unbelievable volume. The reports of the quantities of these highly dangerous war machines Germany was reported to be building were so fantastic that her former enemies laughed them off as being ridiculous. Today the world knows to its sorrow that those reports were modest understatement of the facts.

Why is it that if Germany could jump into plane production practically overnight, as reported, it takes so long for our American plants to step up to a similar rate of production? Germany, aware that an overwhelming supply of machine tools, properly equipped with the necessary gauges and fixtures, would have to be on hand before she dared defy France and England by building a single warplane, devoted the bulk of her financial resources and skilled manpower to building still more and more machine-tool plants. As each new plant was erected and equipped, it immediately went into three-shift production. For building tanks or airplanes secretly? No, for building more machine tools; for machine tools are the only self-regenerating machines yet devised by man. A lathe can be employed for making still more lathes; an iron planer can reproduce itself to the extent of 90 percent of its own weight; a horizontal boring mill can reproduce many of its own parts—and these machine tools, with a few other basic types, can go on reproducing every known kind of machine tool, *ad infinitum*.

Thus did Germany secretly prepare to stun the world with the suddenness of her blitzkrieg victories over her enemies. She was grimly content to disguise her feverish war preparations as peaceful engagement in the manufacture of machine tools which—for some reason that looked silly to her former enemies—she proceeded not to sell abroad but to keep at home and use for making still more lathes and precision grinders and gear cutters and iron planers and milling machines—like the farmer who raised more corn to feed more hogs so he could buy more corn to feed more hogs.

Then suddenly the "foolish" corn-hog-corn cycle of German machine-tool activity came to an end. From out of packing cases and off the warehouse shelves came secretly prepared jigs and fixtures, designed and built for the conversion of this plethora of

Another example of the self-regenerating power of machine tools. A planer planing a bed for another planer. This machine can reproduce itself to the extent of 90 percent of its own weight



machine tools to the mass production of Stuka dive bombers and their motors, for the production of lightning-fast tanks, for the production of machine guns and cannon. Before the world stopped laughing at preposterous rumors leaking out of Germany, planes were rolling from factories at the rate of 1,000 a month and tanks were clicking off the assembly lines like trucks from a Detroit factory.

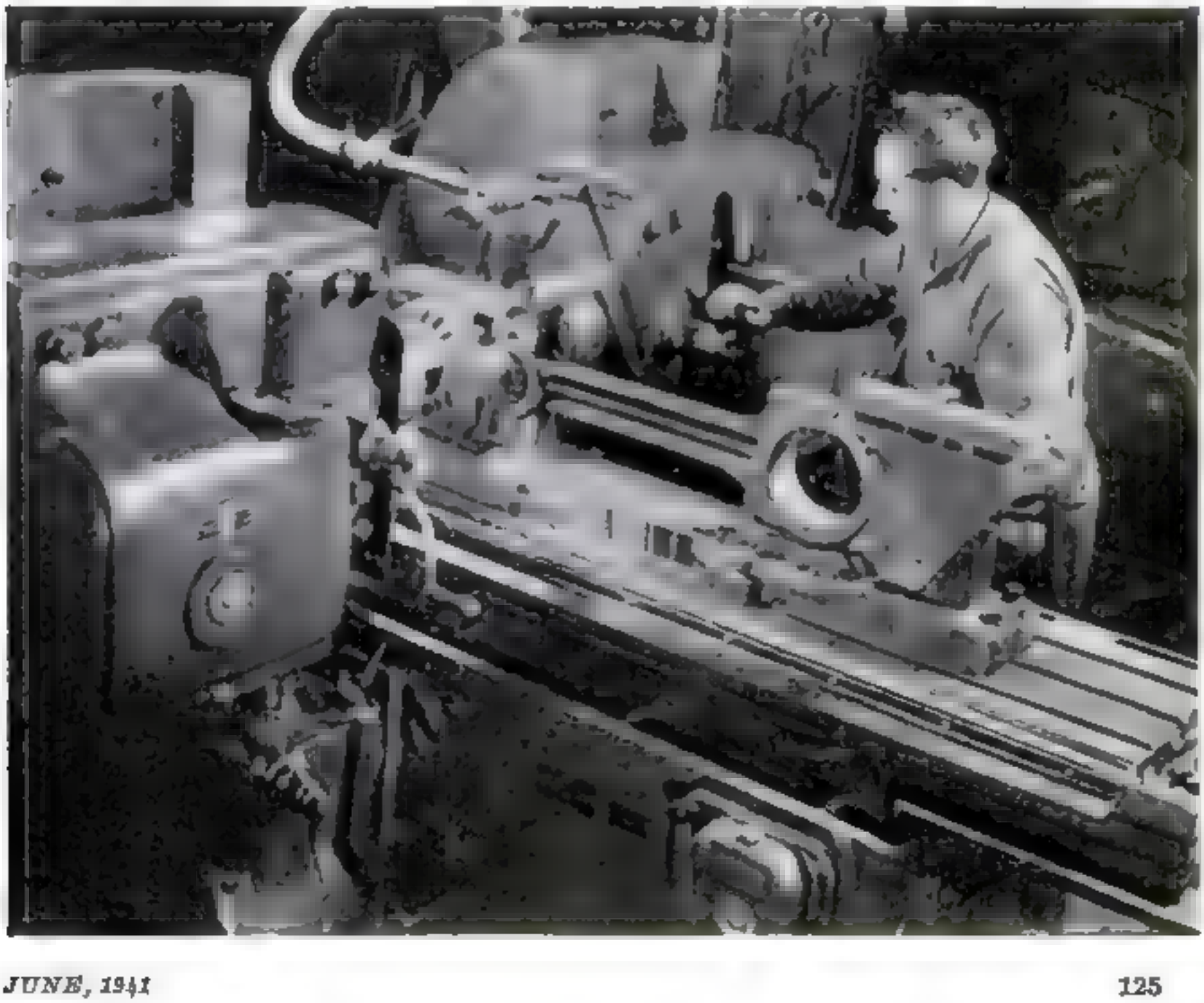
All Germany needed was a few months of such well-planned and integrated production of war materials to outstrip all the reserves that her former enemies had built up on an easy-going production program. A six-months' head start was all Germany dared ask for. She even felt justified in taking the risk of having war declared against her, if only she could be permitted to run her war production plant unchallenged for three short months!

But for nearly two years Germany was allowed to operate her war production plant unmolested before she had to divert some of her energies to war itself. Meanwhile her machine-tool plants were continuing to make still more machine tools and train still more battalions of highly skilled mechanics, while her frightened enemies frantically sought to assemble from the junk yard and the scrap heap enough worn-out and outmoded machines to produce a trickle of war material from neglected arsenals and munitions factories. It was too late then for France.

Germany's experts on war production, with their own machine-tool production facts and figures before them, were confident that it would be utterly impossible for the American machine-tool industry to expand its capacity in time to save England. Had not the entire German nation been working for five years at an all-out pace to expand the German machine-tool industry to the point where it was larger than all the rest of the world's combined? The German temperament is not given to bluffing at any game. And in this case German economists, working from freely available and reliable data on American machine-tool production for as far back as 1929, were able to plot our average capacity curve for machine tools with more than average accuracy.

Going back over the records, German economists found *(Continued on page 228)*

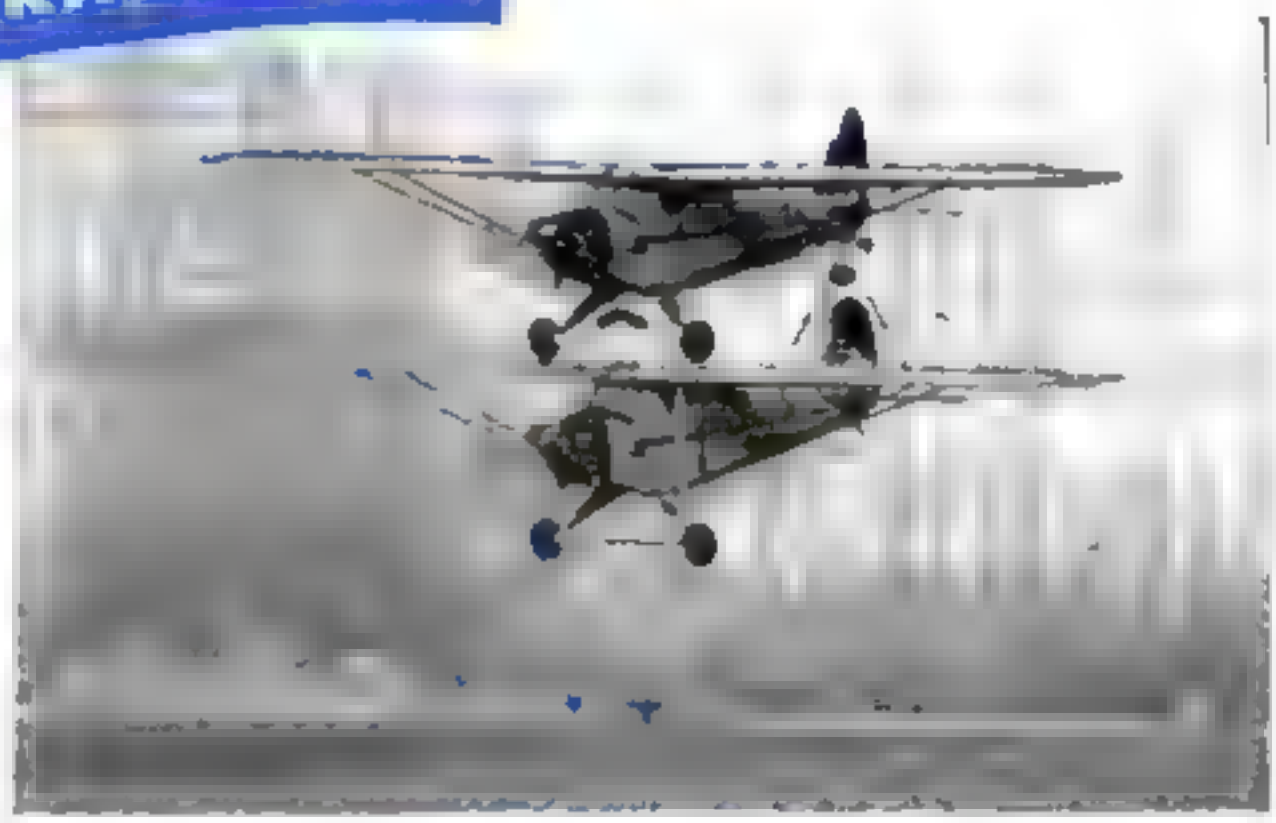
A milling machine simultaneously finishing both sides of a large Diesel-engine connecting rod. Many machine tools can be turned overnight from peacetime work to the making of war materials



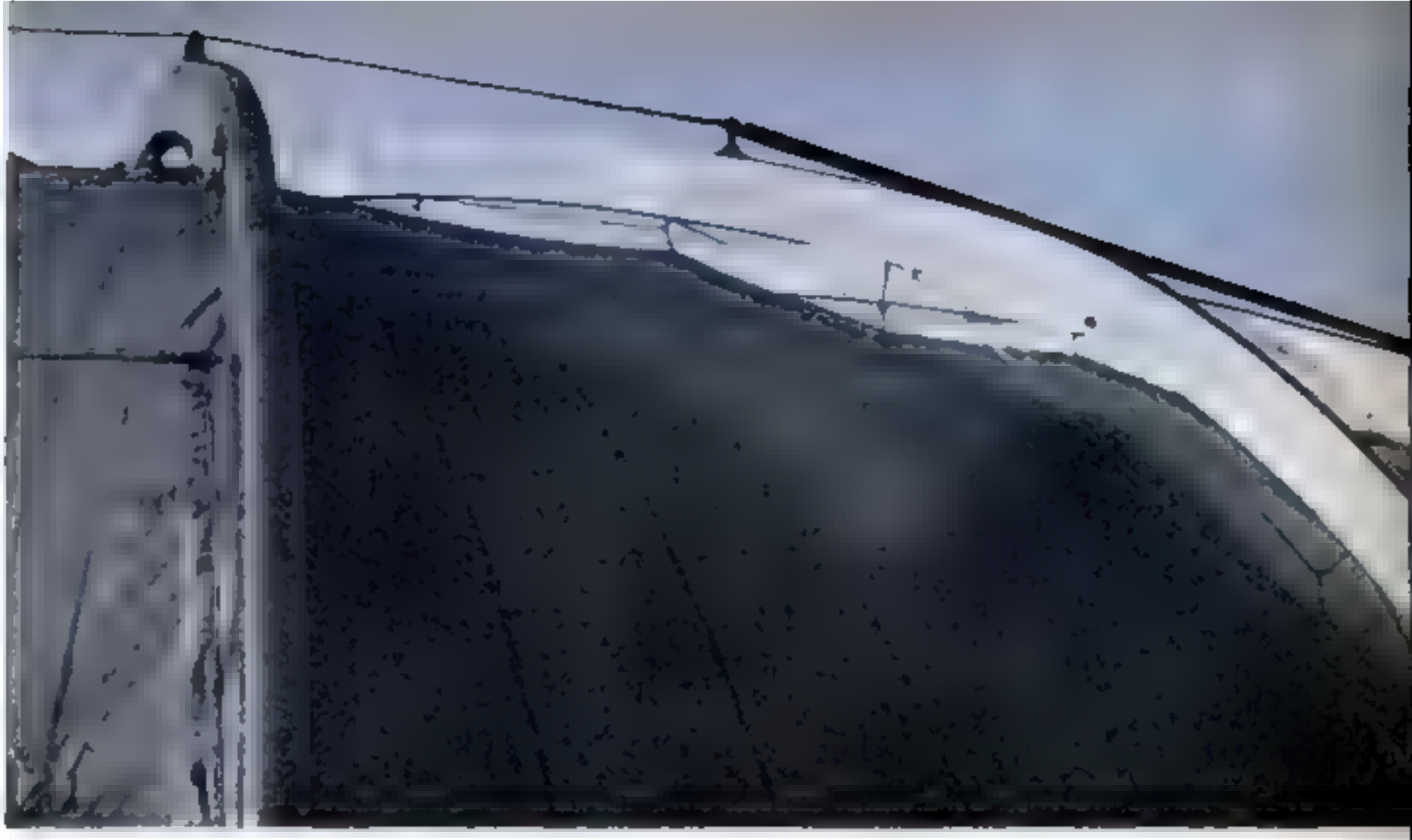
Stunt Planes RIDE PICKABACK

Like a well-drilled team of dancers, these planes do their stunts together

WHEN THE WORLD looks topsy-turvy to Dan Fowlie and Don Berest, they straighten everything out by doing a bit of upside-down flying. To make it complicated, they hook their planes together before taking off. Still hooked together, they perform loops, figure 8's, dives, and climbs. They think nothing of swooping past a grandstand with the wings of their planes overlapping and less than a foot apart, or landing side by side, each plane on one wheel, and taxiing across an airport in that position. So the spectators won't be confused, slogans are printed upside down on the planes.



Fastened pickaback (above) they swoop to the ground after looping and diving, but it's even more impressive when (as below) they fly separately but with wings overlapping and less than a foot apart



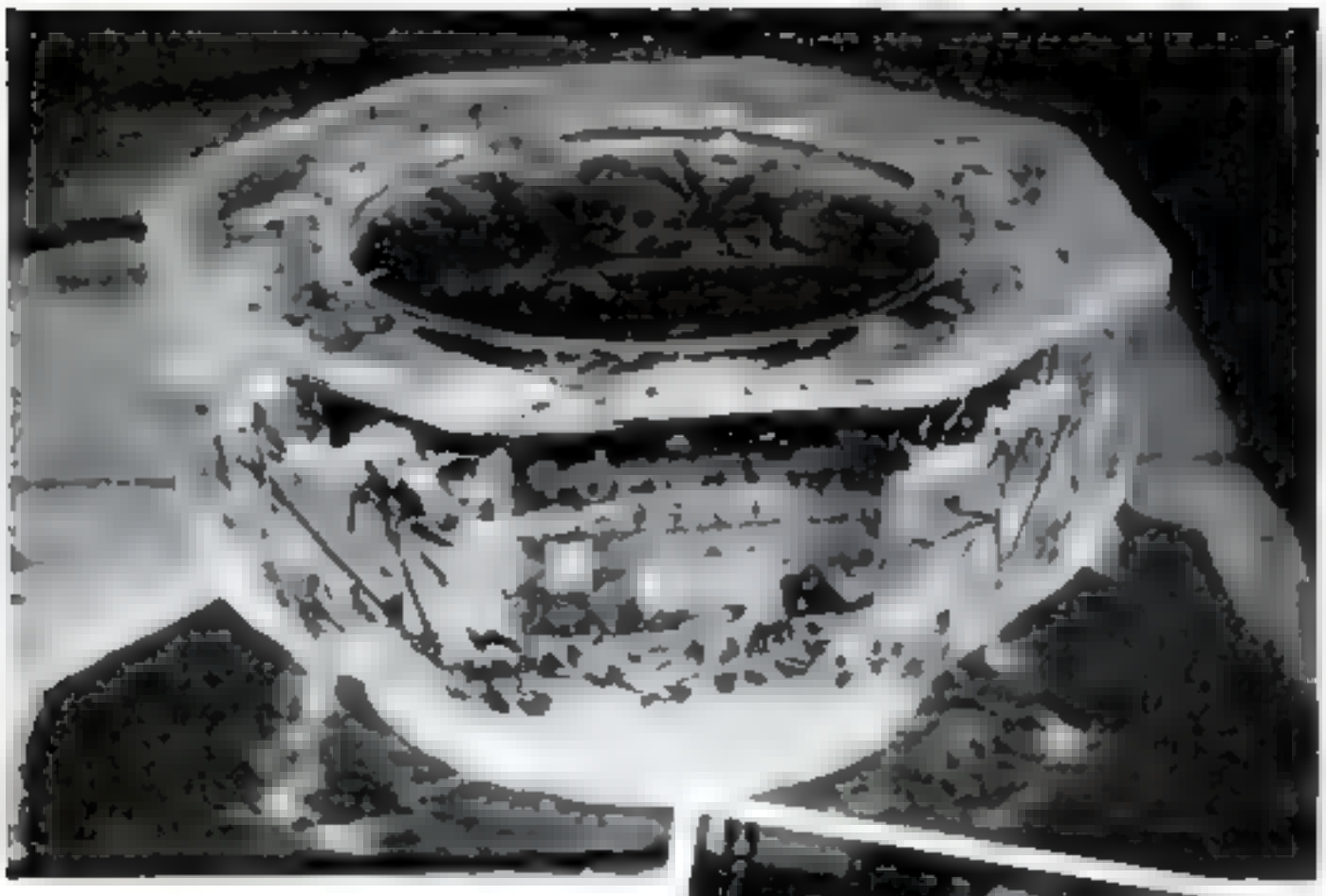
A scientific tent for a traveling exhibit. Sectional struts support the canvas by means of halyards

Aerodome Houses G.M. Show

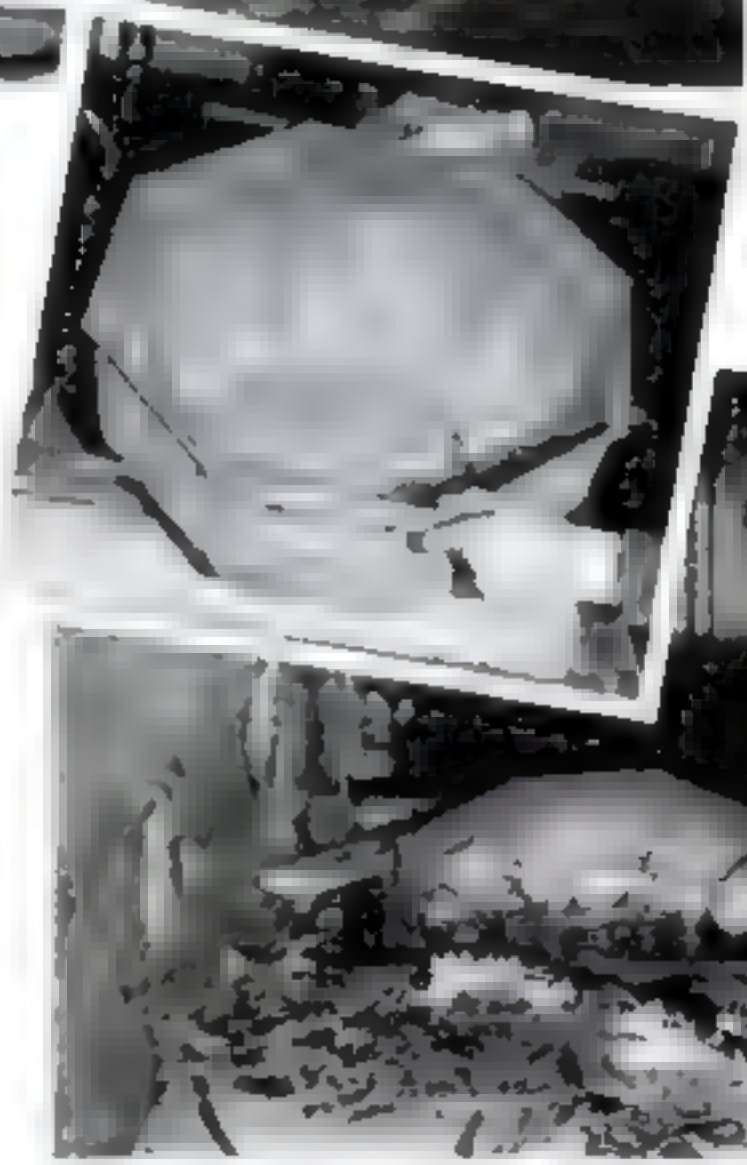
Supported by jointed aluminum girders, this light-proof tent, 80 feet by 135 feet, houses the General Motors "Parade of Progress" exhibit which is now touring the United States in 22 trucks

•

1. Tent hangs on halyards which control its tension
2. Struts made in bolted sections for easy storing
3. Staked foot plates and tie cables anchor the tent
4. Tubular spreaders make solid structure of frame
5. Holes for entrances are closed by slide fasteners
6. Aluminum paint on canvas acts as heat reflector



A punch bowl of ice, decorated with flowers and the cover of your favorite magazine frozen in



To freeze the bowl P. B. McElhenie fills this octagonal mold with water and puts it in a tank of brine

When 1½ inches of ice have formed in the mold, he sticks the decorations on and freezes it again

Decorations Frozen Into Punch Bowls Made of Molded Ice

PUNCH BOWLS of ice, with flowers and other decorations frozen into them, are turned out by P. B. McElhenie, repairman for the Southern Ice Company at Charleston, S. C. He fills a mold with water and places it in a tank of cold brine. When the water has frozen 1½ inches thick inside the mold, he lifts it out, sticks the decorations to the inside of the ice, and puts it back to freeze some more. Such bowls are said to last four or five hours at room temperature.

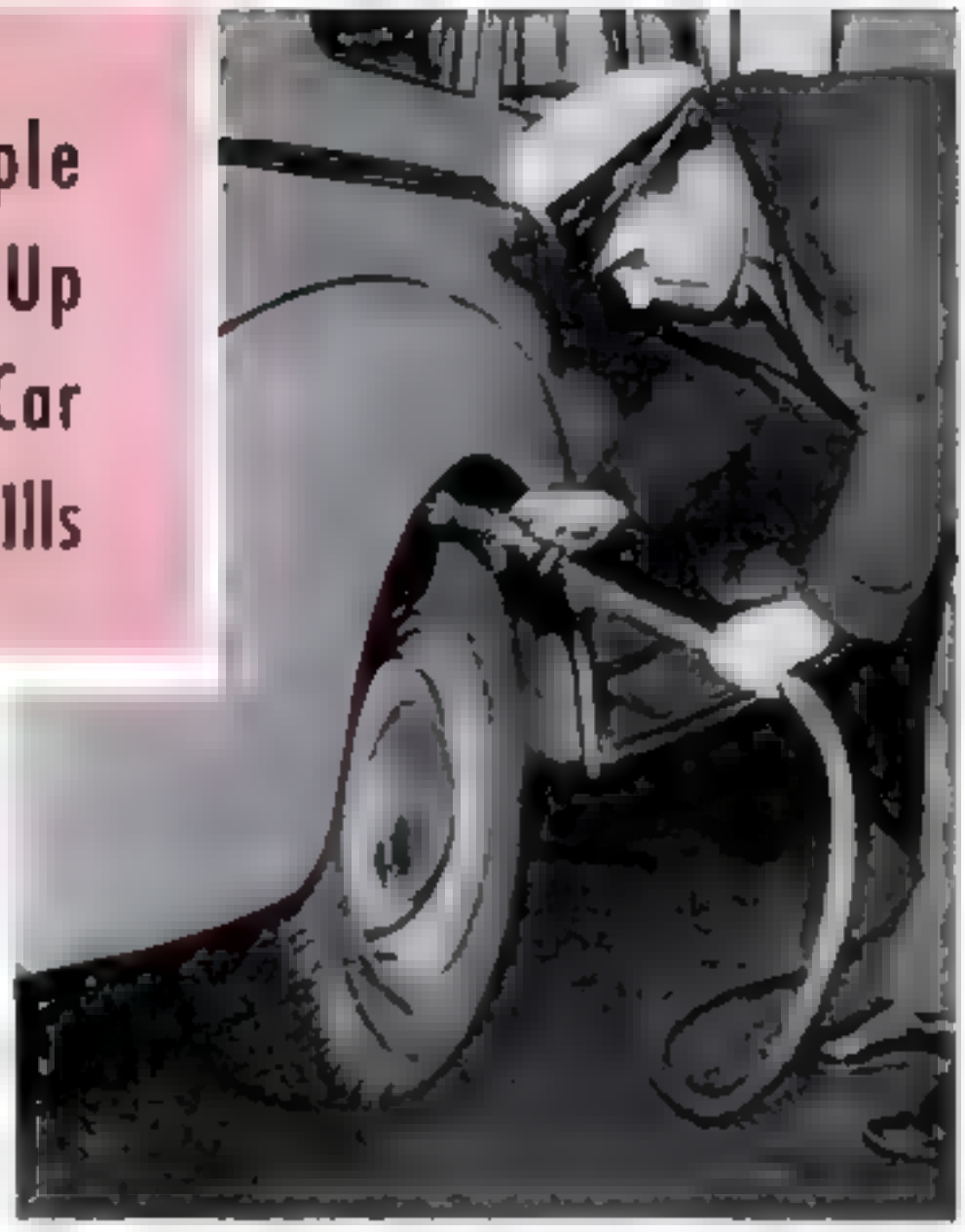
Compact Picnic Cooker Burns "Heat Tablets"

HERE'S a cooking kit for camping and picnics which burns fuel in tablet form. The stove is a metal box containing a framework on which to set pots and pans, and a cup in which to burn the fuel. One tablet will burn seven minutes and heat a half pound of liquid or solid food. For more heat, two tablets can be burned at a time. The fuel can also be used for starting camp fires.

AUTOS

Summer Conditioning Your Car

By Following a Simple Step-By-Step Check-Up You Can Insure Your Car Against Hot-Weather Ills



Ice-melting chemicals splashed on your car should be removed with a pressure hose before they can attack metal

By SCHUYLER VAN DUYNE

WITH summer and the prospect of many long hot drives and short strenuous car errands ahead, the wise motorist will make his automobile ready now for the weatherman's worst. In doing so, he will assure himself of a season of trouble-free driving, and additional dividends will be paid off generously in quieter operation, better economy, easier control, and greatly increased safety.

Typical tasks will be the adjustment of the carburetor pump to deliver less raw gasoline to the cylinders during sudden acceleration, and the replacement of light lubricants with heavier ones where called for. Moreover, steps should be taken now to clean from under the car the ice-melting chemicals splashed up from the streets during the winter months. There will be water condensed in your crankcase and dirt caked on steering knuckles, universal joints, and other exposed parts. Numerous engine accessories such as fan belts and throttle linkages may need attention.

To simplify these jobs for motorists, a brief step-by-step chart of chores for summer-conditioning a car is given on the opposite page. Check off each item as it is

Few batteries wind up a hard winter without need of care. Tests should be made . . .

. . . to show up weak cells, voltage output under load, and the specific gravity of the liquid. Add only distilled water

Brakes are jobs for the expert. Linings and drums should be examined for wear. Leaks in the hydraulic system are danger signals

attended to. When all are checked, your car will be fit for long tours or short hauls, and you'll make the most of the qualities the manufacturer built into it.

The chances are slim that you can do it all by yourself, for many service jobs require tools and equipment you don't possess and couldn't use if you did. Some of the simpler jobs you can handle. But the advice of the experts is that you must not start anything you cannot finish, and that it is a shame to make a guinea pig out of a good automobile just to learn how not to do a job the next time.

In short, use good judgment on what to do yourself and what to leave for your service man. It's a pretty safe bet that the less you do yourself, the better.

The experts break down the jobs on your car into five divisions: Engine, chassis, brakes, wheels, and body. They urge motorists to neglect none of them in the spring overhaul.

Start with the engine crankcase, which should be drained, flushed, and refilled with the oil specified for the season and the car's age. The old oil should be examined for excessive water, which shows up a cooling-system leak; and sludge, which may indicate worn piston rings or valve guides, or a dirty oil filter.

A well-aged car probably needs carburetor work—definitely a job for the experts. However, many carburetors have an adjustment you can make yourself. This is on the acceleration pump that shoots an extra charge of raw gas to your cylinders when you step on it. You can easily set this to pump a smaller quantity of gas, for summer driving.

The fuel pump should be checked and cleaned at the same time, and a new pump diaphragm installed if needed. Remove water and dirt from the sediment bowl, and replace the bowl carefully to avoid damaging the seal.

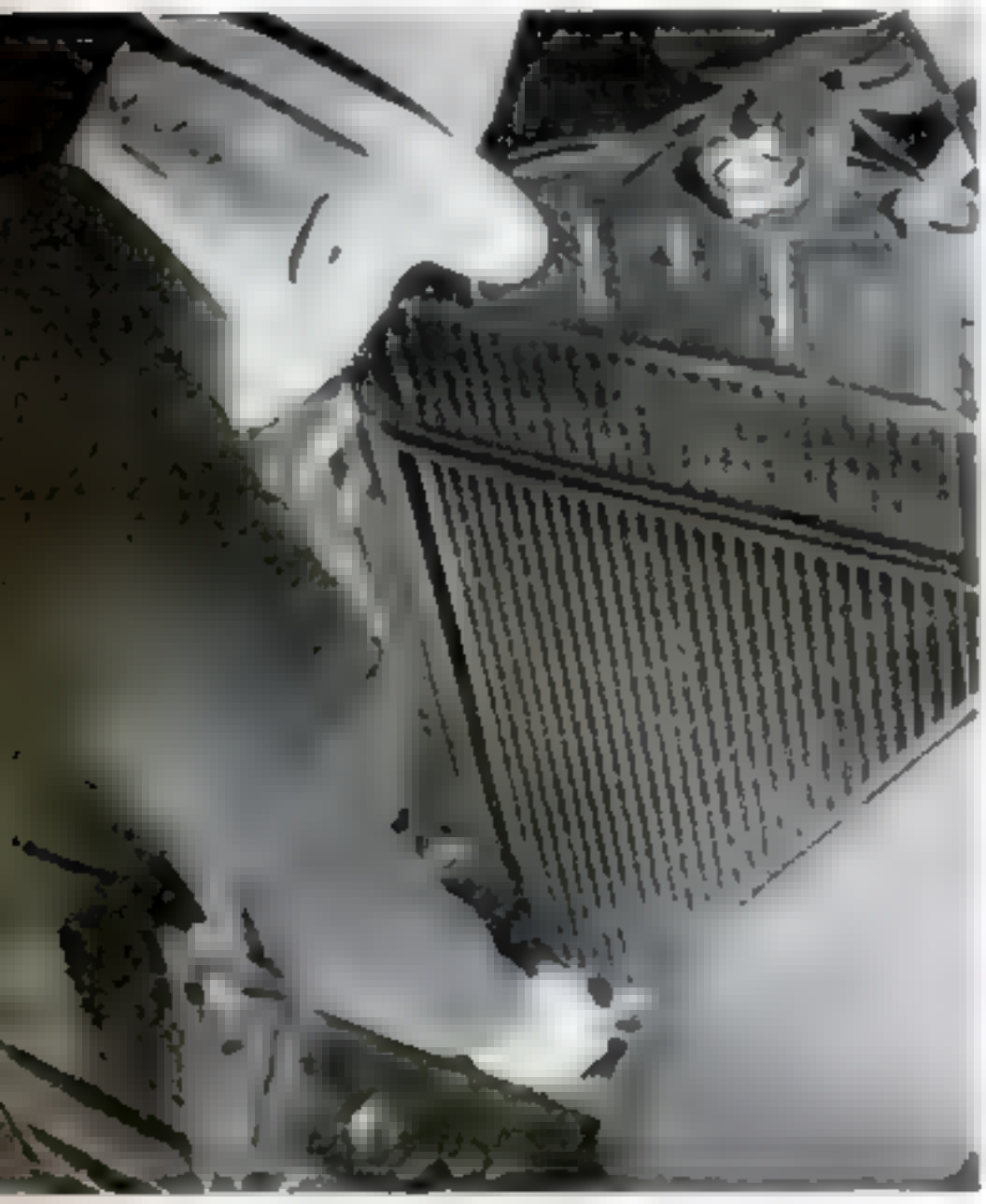
Two other filters on your engine need regular cleaning—particularly at winter's

Summer-Conditioning Check List

ENGINE:	
Drain, flush, and refill crankcase	
Drain, flush, and refill radiator	
Clean carburetor	
Reset carburetor acceleration pump	
Check fuel-pump diaphragm and filters	
Clean air filters on carburetor and oil-filler pipe	
Check oil-filter mileage	
Clean and adjust spark plugs	
Clean and readjust or replace distributor points	
Turn off hot-water-heater valve	
CHASSIS:	
Grease all chassis fittings	
Check (or refill) transmission	
Check (or refill) rear end	
Check battery condition	
BRAKES:	
Check master and brake cylinders for leaks	
Check hydraulic lines	
Check brake drums	
Check brake linings	
Check brake rods and cables (if mechanical)	
WHEELS:	
Check tires	
Check wheel alignment	
BODY:	
Check all lights	
Oil door hinges and latches	
Clean under fenders and chassis	
Clean and wax finish	

end. They are the carburetor air cleaner, which requires a gasoline wash, a short drying, and a thorough soaking with engine oil; and the oil-filler cap—the automobile engine's most neglected orphan child. The latter does double duty as air intake and air filter for the carefully engineered air-conditioning system built into your crankcase, extracting the bearing-destroying abrasives of air-borne dust. Give it the same treatment the carburetor air cleaner gets.

Spark plugs, distributor points, and ignition wiring come in for attention next. You need an ignition expert for this, too, with tools, meters, gauges, and testers. Few cars, after a winter's driving, will fail to show improved gasoline economy after a proper ignition overhauling.



Drain alcohol from your radiator, then apply a water hose to the filler pipe and flush the system for several minutes. Running the engine will help to . .

. . remove rust from the engine block, but be sure of adequate water supply during the running. After refilling, turn off the supply valve to your heater

Under the "engine" heading, there remain but two major items: drain, flush, and refill your radiator if you have been using alcohol as antifreeze; and turn off the water supply to your hot-water car heater. If you used an ethylene glycol antifreeze, opinion is divided on whether to leave it in or drain it and store it for next winter. It is a good idea to flush out the radiator and engine block anyway, whether you put the antifreeze back or not. And when the flushing job is finished, then, and not before, shut off the heater valve.

The chassis comes next on the program. The first step is to get it clean of salt, calcium chloride, and other chemicals that the highway departments put on the streets to melt snow and ice. Most such chemicals slowly attack steel. They also attack rubber fittings, with which the modern car chassis is liberally equipped. A pressure-hose bath, elbow grease, and a stiff brush will be needed.

Proceed from here to a thorough greasing job, changing grease and oil where recommended, with special attention to the requirements of hypoid rear ends and of fluid drives and hydramatic clutches and transmissions. Next, check the battery cells individually and collectively for voltage output, and add distilled water to cover the plates. A battery hydrometer will show the state of charge of the cells.

Brakes are the province of your service man. Just to remind you why, recall that the master and the wheel cylinders, pistons, and linkages need inspection to show whether repairs or replacements are called for. Brake linings should be examined also for uneven wear, and brake drums for high and low spots. If your brakes are of the mechanical type, rods, levers, cables, and other fittings require equally careful inspection.

Car wheels, after a season of skidding on ice, pounding over ruts, and plowing through heavy snow, should be checked. Rear wheels rarely get out of line except from collisions, but front wheels, more flexibly mounted, often give alignment trouble. Bad steering, shimmy, rapid tire wear, and sideways "drag," are a few of the symptoms here. In addition, the tires should be gone over for cuts, bruises, and potential punctures from bits of glass and wire, nails, tacks, and stones. And remember that no inspection—except by an X-ray machine—reveals the condition of the inner walls of tires

unless the tires are taken off the wheels, tubes removed, and the casings spread open.

The car body is next, and it is well to include all lights—head, tail, interior, parking, and turn-indicating —in the list of things to be checked in this department. Your garage man will check on headlight-beam direction. Following this, thoroughly clean dust from the floors and upholstery, and remove upholstery spots with an approved spot-removing compound.

After a good washing, your car is ready for waxing—another elbow-grease-consuming task, but one that repays you well in improved car appearance and increased life of car finish. The wax will make subsequent cleanings easier, too, since a quick rubbing with a dust cloth restores the luster when needed.

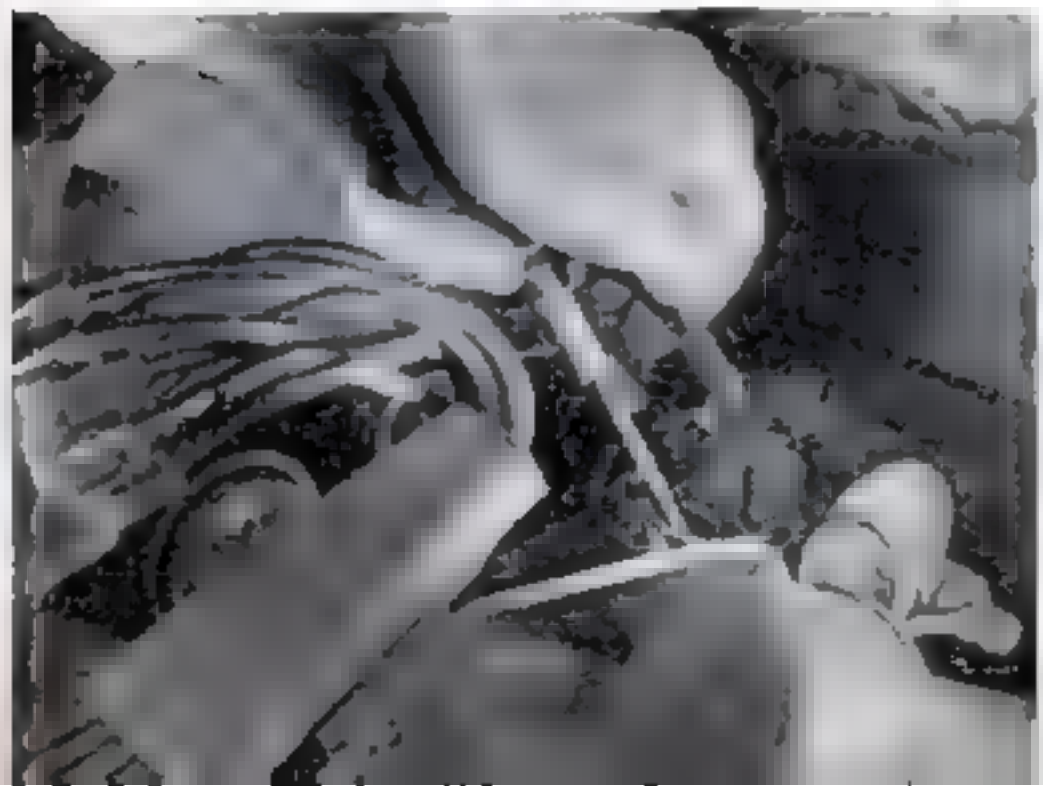
Lastly, apply light oil to door latches, locks, and hinges, carefully wiping off any excess that might spot clothes. You'll be amazed at the number of squeaks, rattles, and canary birds bothering you for weeks that suddenly disappear, just from this simple treatment.

If any detail of automobile maintenance is to be stressed over others, it probably is lubrication. While oil companies have developed lubricants in recent years to perform astonishing tasks compared with those of ten years ago, the best of them have a limit to the miracles they can perform. And proper car lubrication, is not alone a summer-conditioning chore but a year-round service "must" for those who want their cars to give them trouble-free, economical driving.

All in all, the jobs to be done on your car now are many. After you've done what you are equipped to do yourself, turn the rest over to a skilled garage man. He's an old hand at summer-conditioning cars. So he'll probably repeat the chores you've done, then finish the job with all the technical skill that it calls for.

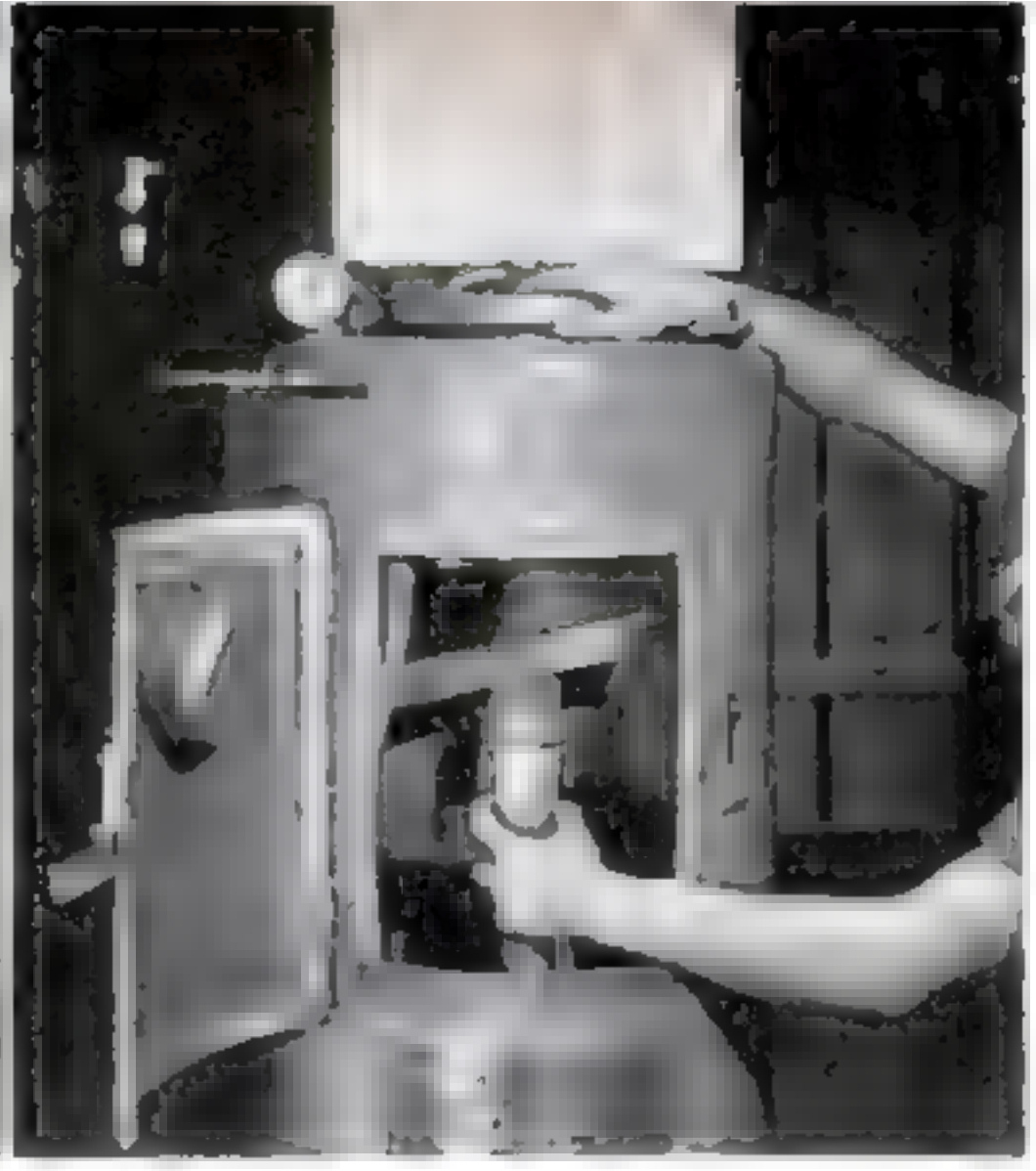
Remove spark plugs, clean them carefully, and reset the points. This is another job best left to the . . .

. . . experts, along with cleaning or replacing and adjusting the distributor points. Properly handled, this treatment greatly improves car performance



Preliminary step in tire check-up. To be thorough, you should remove the tire from the rim and the tube from tire to inspect the inside of each shoe

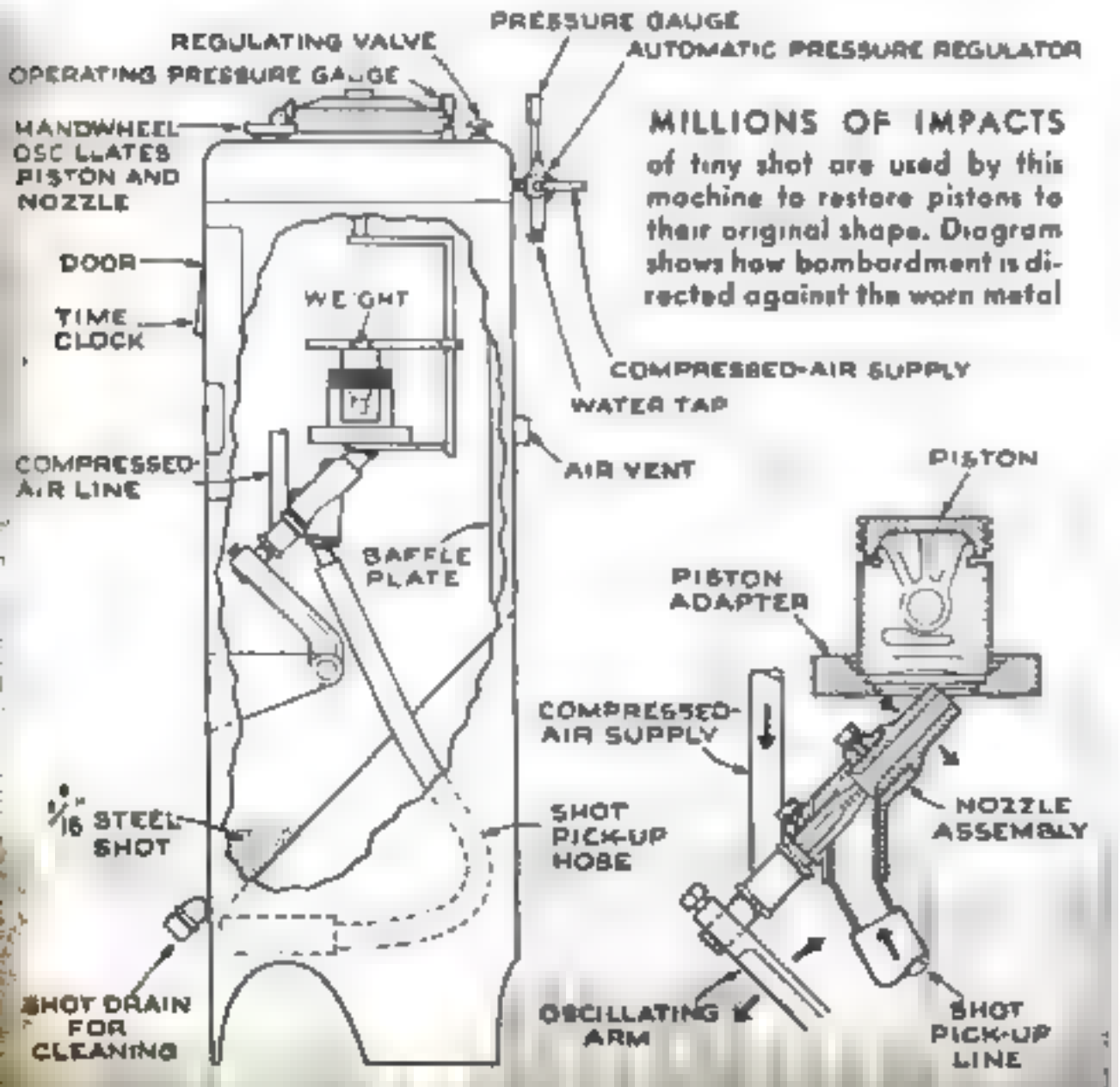
Inside, a spray of shot is expanding a piston. A wheel, steadily turned, keeps jet in motion



Removing piston after Koetherizing. Large wheel on top controls oscillating table which holds piston

Spray of Shot Expands Worn Auto Pistons

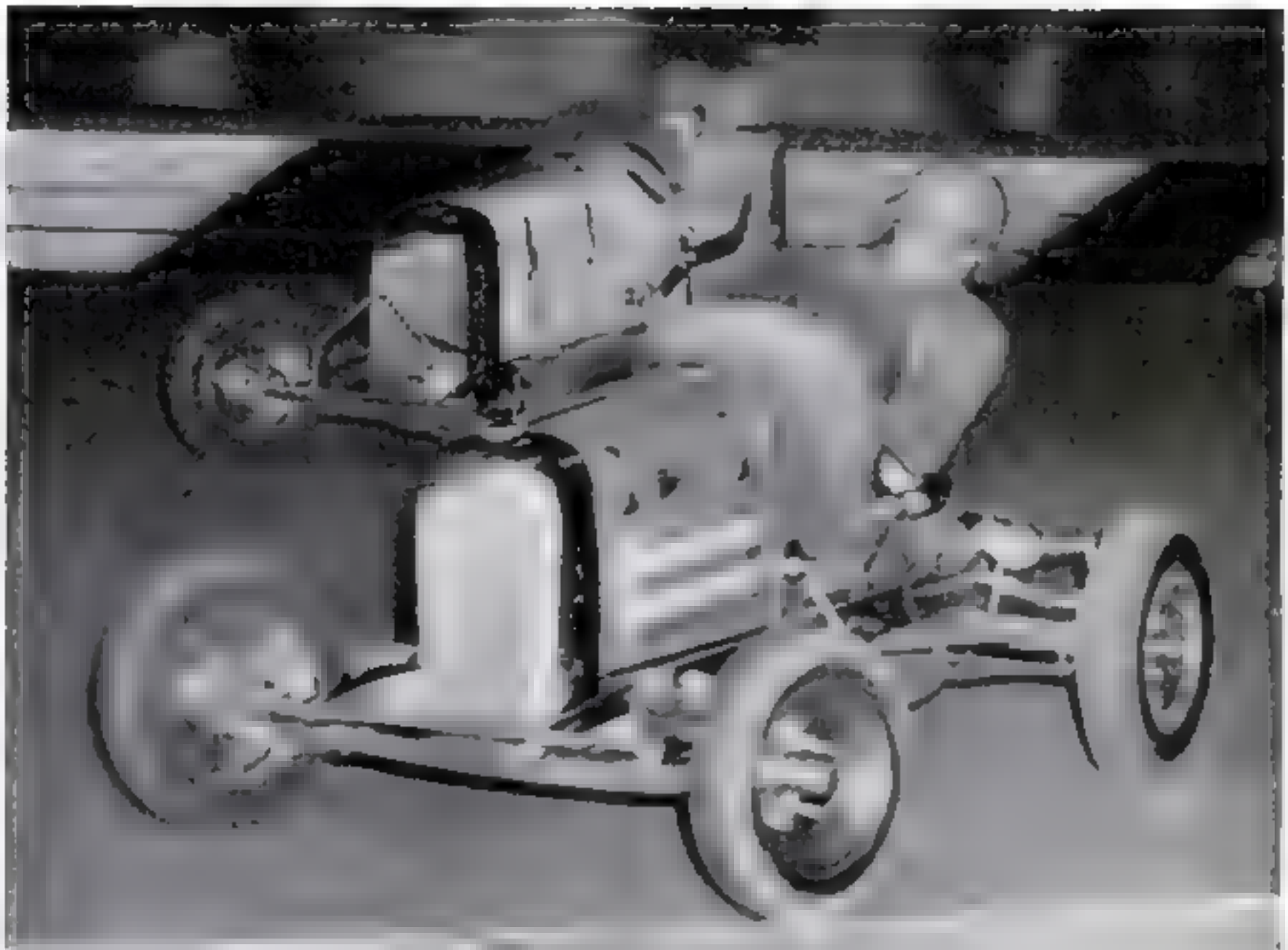
FINE STEEL SHOT, sprayed against the inside of auto-engine pistons by a blast of compressed air, has proved an effective means of expanding piston skirts that have become too small because of wear or "collapse" of the metal. Named Koetherizing after its inventor, E. A. Koether, this method restores pistons to their original size in a few seconds. Pistons to be treated are first measured to see how much expansion is needed, and then placed in the "Koetherizing" machine. A chart shows the length of treatment required to restore the piston's size, and a timer on the machine tells the operator when the proper amount of spray has been applied. The piston is fastened to an oscillating table. While the treatment is under way, the operator turns a small wheel on the top of the machine which moves the spray jet providing a proper distribution of pressure on the piston. The sprayed shot does not strike the piston pin bosses or struts, which might be distorted by the application of so much pressure. Number 16 shot is used, which is about as fine as granulated sugar, and it is blown against the piston by air under a pressure of 60 to 80 pounds a square inch, depending on the type of piston. Inner surface of the piston is strengthened and hardened by the process.



MILLIONS OF IMPACTS

of tiny shot are used by this machine to restore pistons to their original shape. Diagram shows how bombardment is directed against the worn metal

POPULAR SCIENCE



Sam Hanks (outside) and Pat Cunningham, star midget-car drivers, skid on a turn at a mile a minute

Battle of the Mighty Midgets

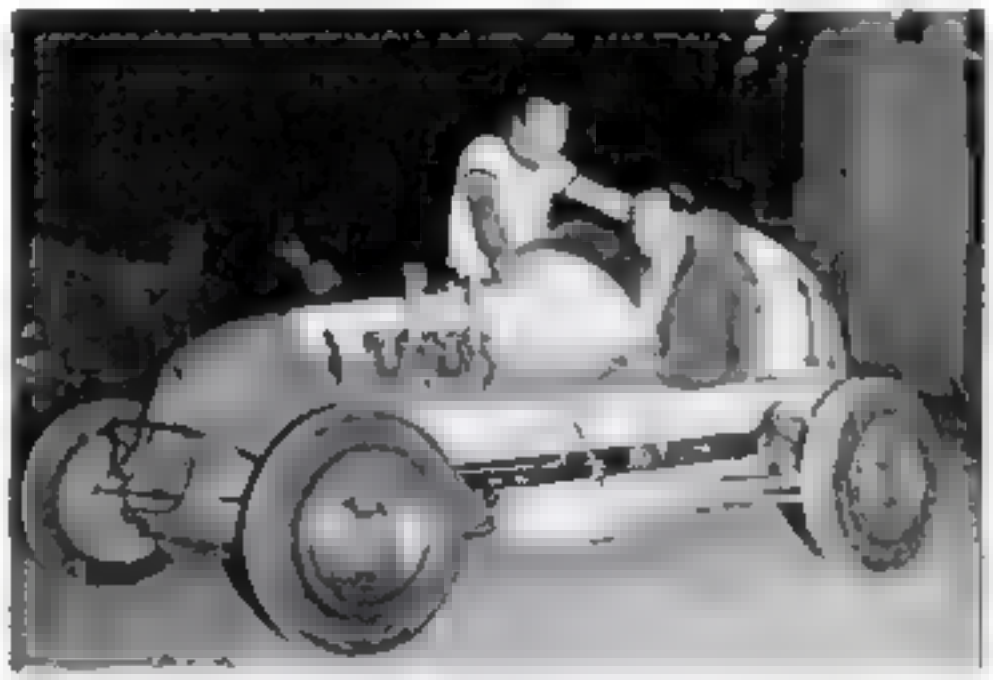
By ANDREW R. BOONE

LURED by $1,000,000 in prize money, drivers of 5,000 midget autos race thousands of miles every year, while more than 5,000,000 spectators throng to 300 tracks to watch them flirt with sudden death. Speeds of 75 miles an hour on the straightaway are not uncommon, and some of the speed bugs average a mile a minute in races on fifth or quarter-mile oval dirt tracks.

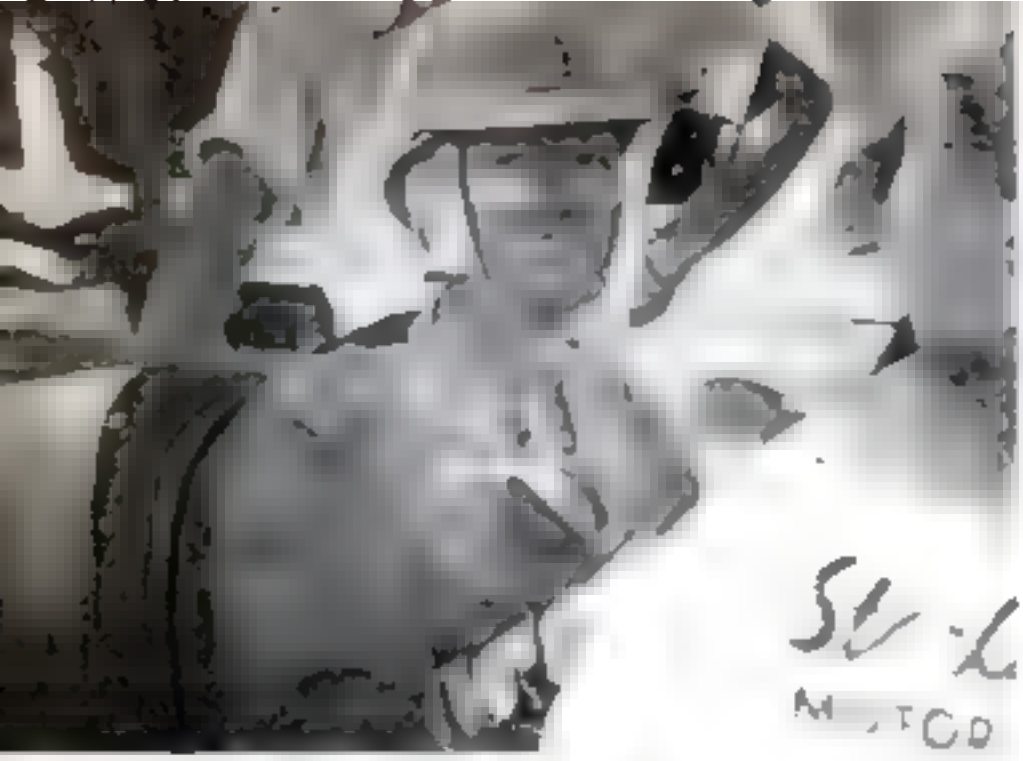
So rapidly has this speedster's sport spread since the first midget races were held at Loyola University's stadium in Los Angeles in 1932 that several dozen circuits now operate throughout the country. Many owner-and-driver teams spend their time playing one-night stands, covering six tracks a week. After each meet they load their racers onto trailers and drive through the night to the next meet, which may be as far as 400 miles away.

Power plants for their churning chariots may be anything from a rebuilt, two-cylinder motor-cycle engine to a complicated four-cylinder, 16-valve, double-overhead-camshaft, dual-carburetor job that can turn up 6,800 revolutions a minute.

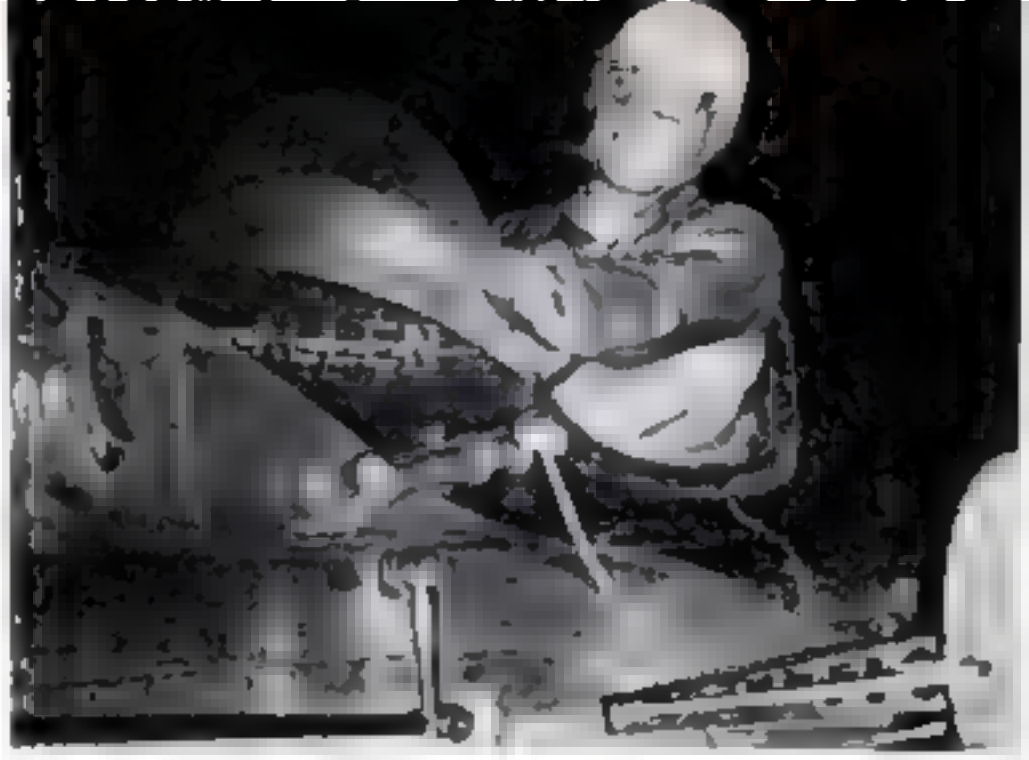
Scores of successful midgets are powered with the four-cylinder, eight-valve engines



This speedster, driven by Ed Haddad, has novel bumpers to prevent serious crashes when it bumps into other racers



Ronnie Householder, ace of the western tracks. Crash helmet and goggles ward off flying clods



Most expensive midget is Charlie Allen's $6,000 job. Perforations in windshield cool the driver

Bud Lewis, one of the top "B" class drivers on the Pacific Coast, looks grim at the finish line

turned out by Fred Offenhauser, who has also turned out winning engines for cars racing in the annual 500-mile Memorial Day race at Indianapolis. His midget creations sell for $1,800, minus gear train, carburetor, and magneto.

The "Offies" were hard to beat for a long time, but those 16-valve jobs which are being produced by Alden Sampson, another Los Angeles motor builder, are giving them some stiff competition. Ronnie Householder, one of the top-flight midget drivers, recently installed one in one of his two cars. The second was powered with an "Offie." When the two cars were pitted against each other both of them established new records for the track on which they were running in a qualifying round.

Anyone who has the $2 entry fee and the car can enter a midget race, though he's expected to be a skilled driver before he tries it, for his own sake and that of the other drivers on the track. To get their initial experience, many of the beginners pick a flat field or an empty airport, stake out an oval

Mighty midgets lined up near the pits at Gilmore Stadium, Los Angeles, one of the leading centers of the sport. Races are held on about 300 tracks

Householder set a track record at Gilmore Stadium (14.91 seconds for the quarter mile) with this car

. . and this 16-valve Sampson engine. Note dual carburetors and the fine construction throughout

track, and go whizzing around all alone.

Most of the midget drivers are in the game for the thrill of it, but there's money awaiting the consistent winners, most of whom devote their entire time to the sport. Top-notchers can make as much as $10,000 in a year, though much of it goes back into the upkeep of the midgets. Householder, for instance, keeps on hand at all times $5,000 worth of spare parts for his two cars.

There are plenty of thrills for spectators as well as drivers. One car recently did an end-over-end down the track, landing wrong-side-up on its driver, who walked off unin-jured. Occasionally a midget becomes a flaming torch when a gas line breaks. Or a tire blows out, throwing the racer into a wild skid in the path of the following cars.

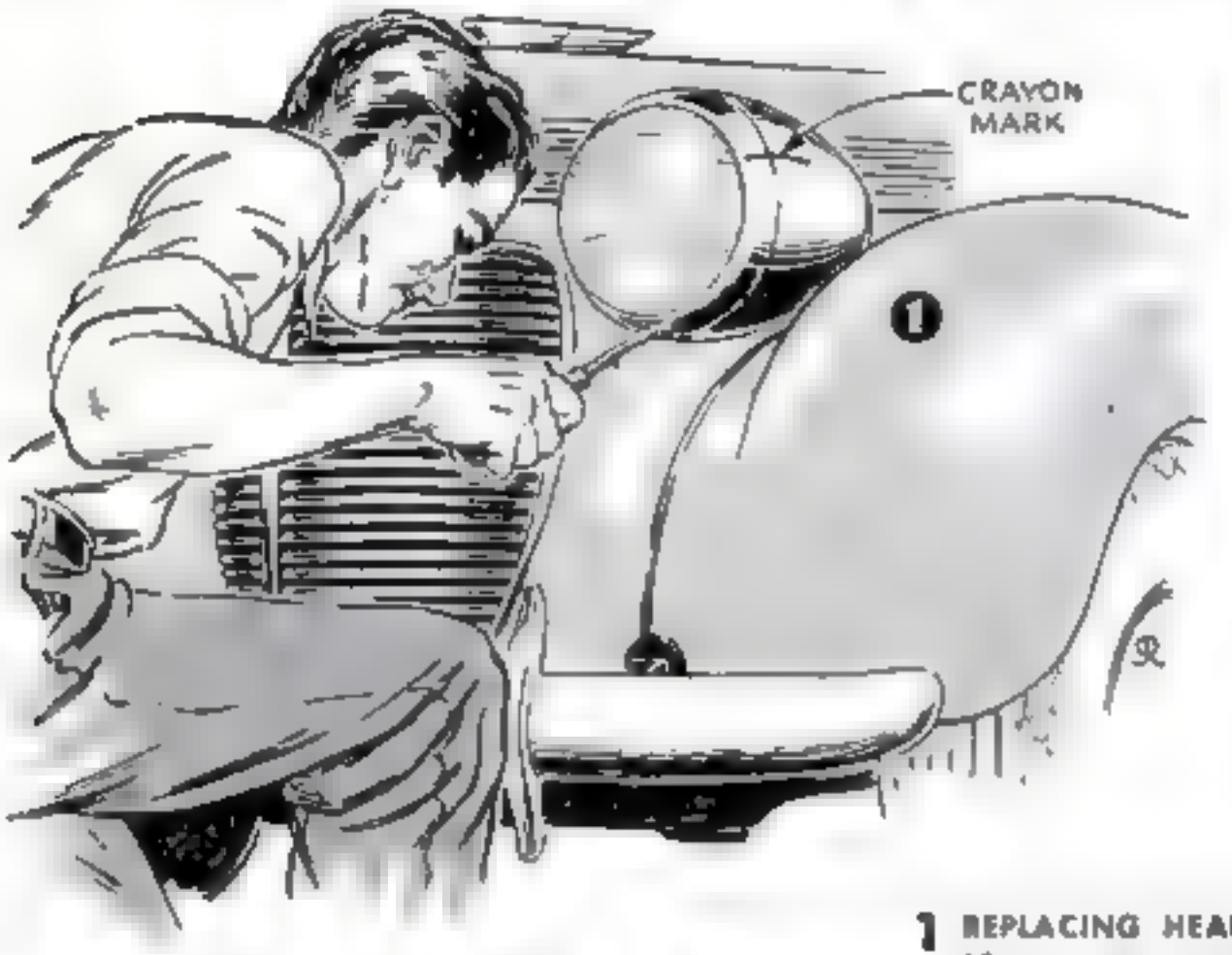
So far, there has never been a bang-up national meet to see who is the national champ of the sport. The midgeteers are hoping, however, that someone will arrange a 200-lap, 50-mile contest that will test drivers as well as machines, to see which is the nation s nightiest midget.

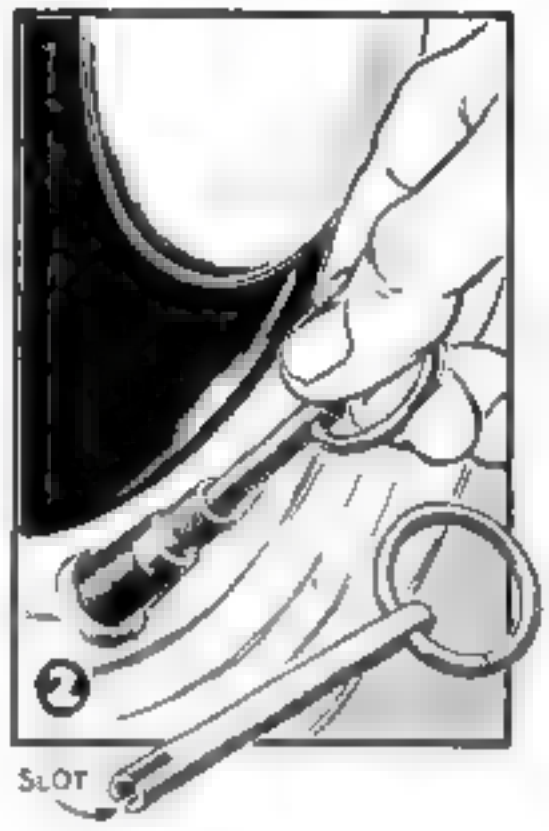
In his garage workshop, Householder fits piston rings while reworking an engine between races

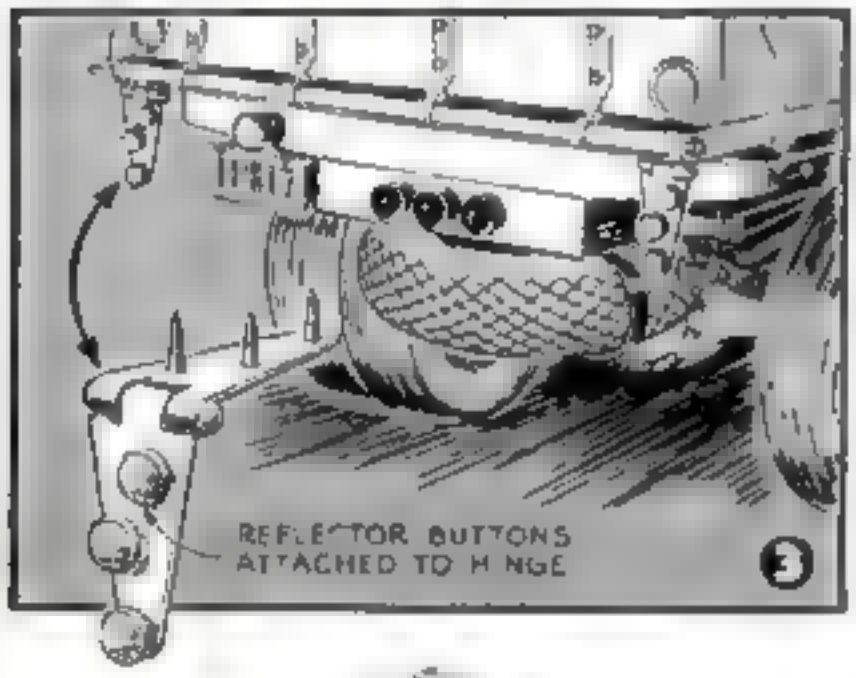
With this tiny crane, which he designed himself he can pick up his cars easily for repair work

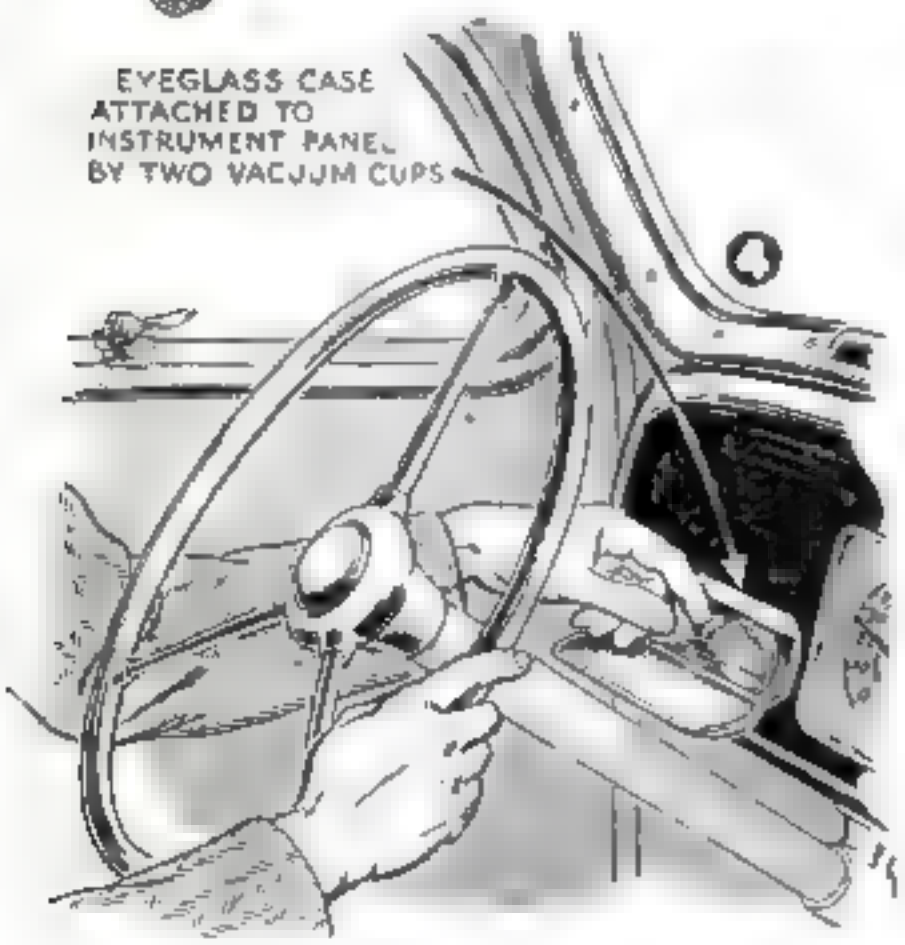
If track conditions change just before a race, Householder can change gears in eight minutes

EIGHT TIMESAVERS









1 **REPLACING HEADLIGHT RIMS** is much easier if you use a simple trick that I tried out with great success. It consists of just marking a line with crayon or chalk across the edge of the rim and the edge of the lamp housing—this before you have removed the rim. Replacing the rim, use the line as a guide. The holding screws then will be easy to put back.—L.D.

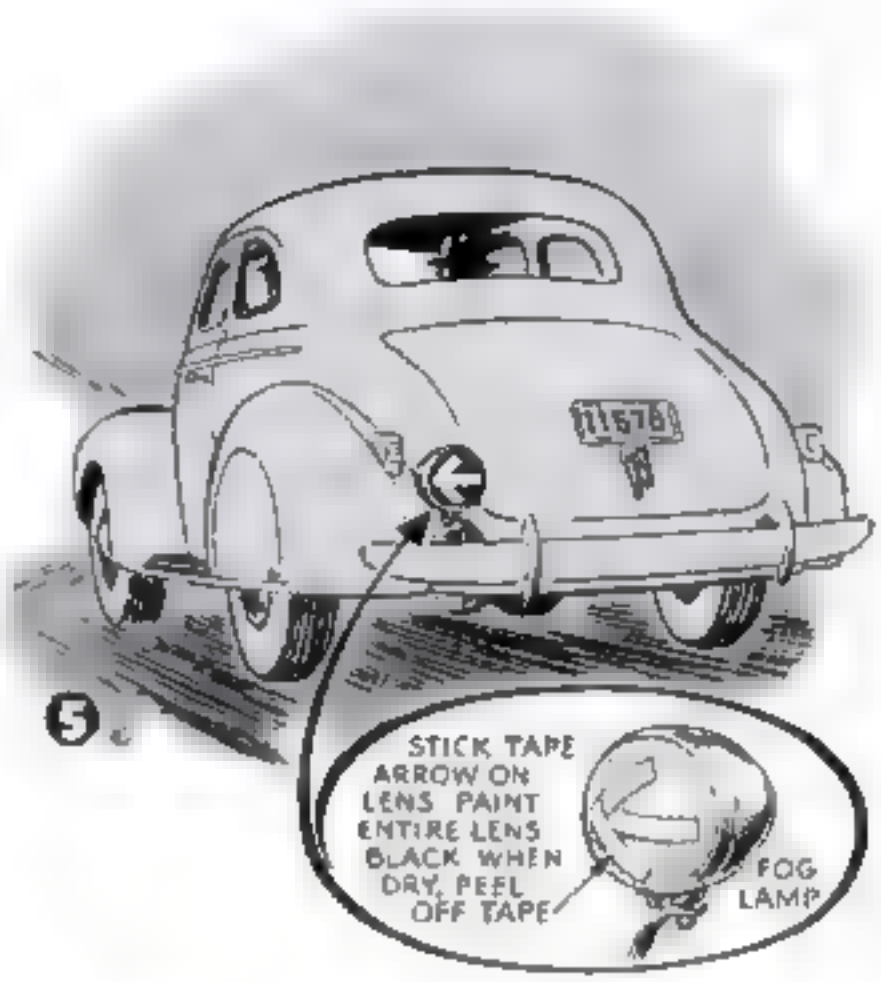
2 **TIRE VALVES CAN BE REMOVED** quickly with a tiny tool you can make yourself and carry on your key ring. It is particularly useful for tires whose caps are not equipped with slotted stems. Obtain a short metal tube of suitable diameter, slot one end as shown in the sketch to fit over the keys of the valve insert, and attach a ring in the other end to go on your key ring.—R.W.

3 **SWINGING RED REFLECTORS** will attract more attention than stationary ones behind your truck. Using free-swinging strap or T hinges, fasten reflector buttons, of the type sold for attaching license tags, to the holes in one leaf of each. Then screw or bolt each other leaf to the back of your truck or trailer. Motion of the vehicle will make the hanging leaves swing.—A.H.W.

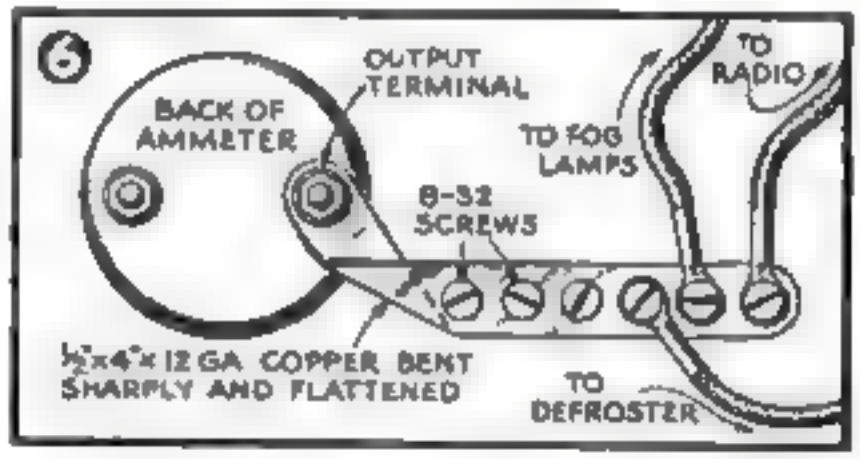
4 **A DASHBOARD HOLDER** for eyeglasses can be made from a metal glasses case and two inexpensive rubber vacuum cups. Screw the cups tightly to the bottom of the case through holes drilled for the purpose. Cover with adhesive tape any projecting metal in the case, and press the cups wet with glycerin against the dash.—R.C.D.

FOR CAR OWNERS

5 A LEFT-TURN SIGNAL I made from an old fog light whose reflector was too dim for its original purpose has proved very satisfactory. I cut strips of adhesive tape and applied them to the lens to form the arrow, and painted the whole surface black. When the paint dried, the tape was peeled off. A dash switch controls the lamp, which I installed as shown.—C.H.

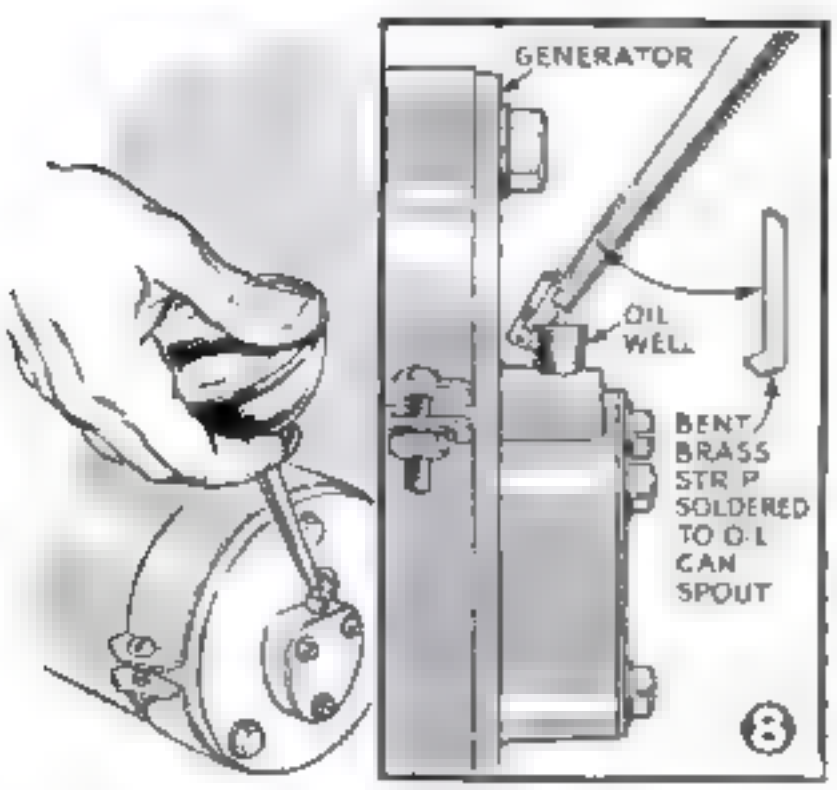


6 ELECTRIC ACCESSORIES, such as fans, fog lights, and heaters, can be more easily attached to the output side of your car ammeter with the terminal strip installed as shown. The copper strip can be bent easily in a vise. Leave adequate space between the set screws.—J.J.B.



7 SINGLE PIECES OF LUGGAGE, if simply thrown into the luggage compartment of a car, are apt to be jounced around and to emerge with corners chafed and the appearance generally marred. I put a firmly inflated old inner tube around my valise and set it on the trunk floor. The trunk lid, when closed down tight, squeezes the tube just enough to hold it and the bag firmly, no matter how rough the road may be.—E.S.

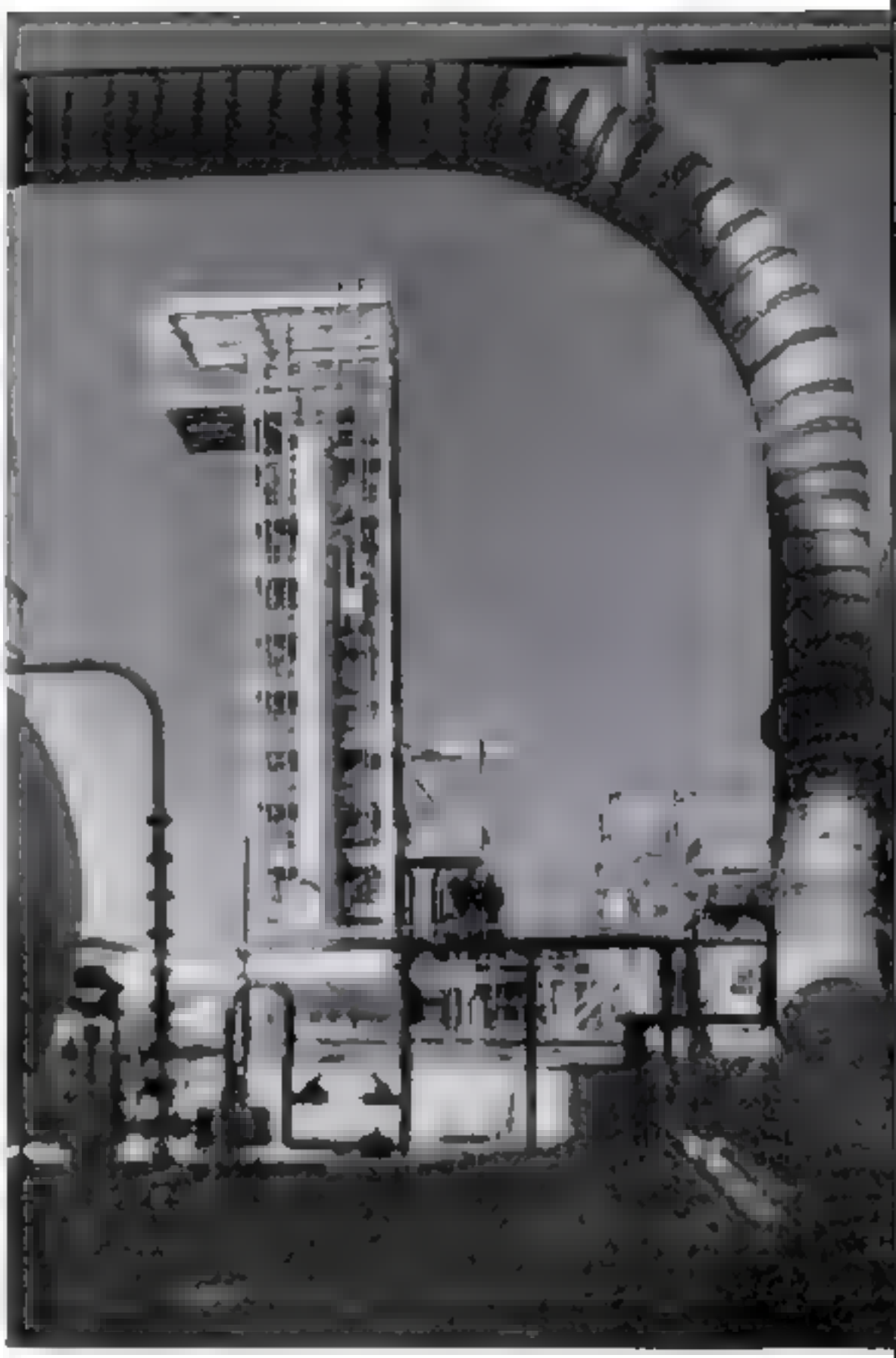
8 TO SIMPLIFY OILING starters and generators, I soldered a tiny angle of metal to a point close to the tip of the spout of my oil can, as shown in the illustration. This serves as a hook to catch under and lift the tiny spring-tension covers on the oil-hole caps. The tip of the spout can be lowered into the hole to keep the cap open. It permits one-handed operation, and also keeps dirt from getting into the spout in the course of the operation.—F.G.



Patented Process Gives

High-Octane Gasoline

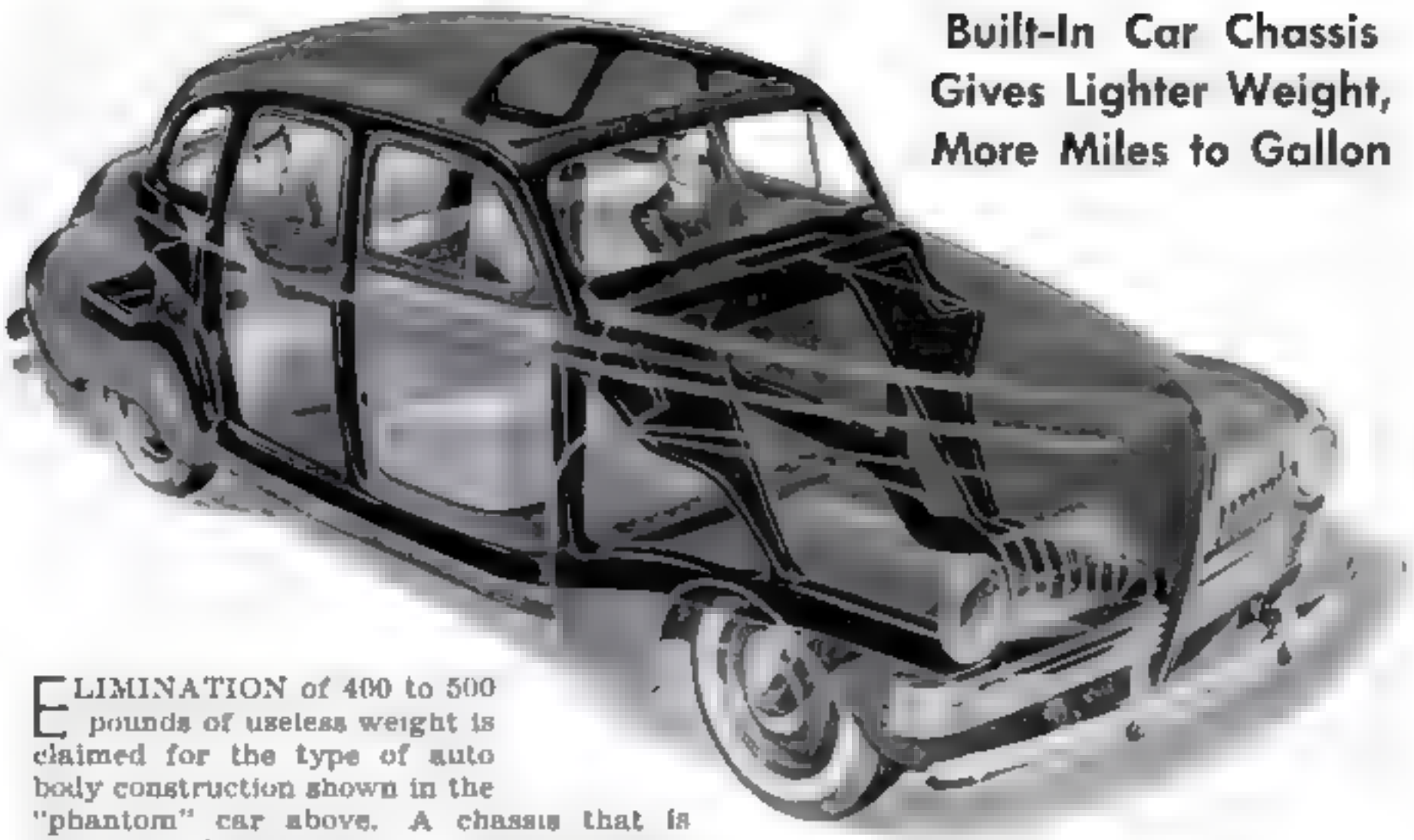
W. S. Farish, president of the Standard Oil Company of N. J., beside a model of the new "fluid catalyst cracking" apparatus for high-octane gasoline. Right, a type of refinery in which the new system will be installed



BETTER gasoline and more of it at no increase in manufacturing cost is the promise in a new petroleum cracking process recently developed by the Standard Oil Company of New Jersey. Yielding up to half again as much gasoline from stock as present thermal cracking plants, the new process turns out 90-octane fuel, 10 octane higher than called for by present cars, and only 10 octane below that required for military airplanes. Blending with lower grade fuels or with antiknock chemicals readily makes it suitable for either use.

Known as "fluid catalyst cracking," the process does away with the delays common to present catalyst cracking plants by keeping an automatically cleaned fluid catalyst, or reaction speeder, flowing in a continuous stream through the refining system. To use the new process, three plants with outputs of 6,000 barrels a day each are being built.

Built-In Car Chassis Gives Lighter Weight, More Miles to Gallon



ELIMINATION of 400 to 500 pounds of useless weight is claimed for the type of auto body construction shown in the "phantom" car above. A chassis that is part of the body instead of a separate piece, and internal bridge trusses, all welded into a single frame, are used to form a unit that is said to be twistproof and rattleproof. The saving in weight makes it possible to get more miles a gallon of gasoline without decreasing the power or size of the car. Coil springs support the weight of the car body at all four wheels.

Folding Vise Bracket Fits on Truck Floor

DESIGNED to provide a convenient support for pipe or machinists' vises, a recently developed bracket can be fastened to a truck floor in such a manner that it can be swung outside the truck to give plenty of room for using large tools on material clamped in the vise.

Device Checks Highway Surface

TO DEVELOP smoother highways, the California Department of Public Works builds roadways of various materials on an oval test track and then checks the evenness of the surface with the "rough-o-meter" below. Two sets of runners transmit irregularities in the surface to a tape in the upper part of the device, where they are recorded. By charting changes from month to month, pavement life is estimated.

"Dad's done something foolish to his car," the girl said, "and I've had to tow him down here"

GUS rescues an amateur

By MARTIN BUNN

IT WAS getting along toward five o'clock on a warm spring Saturday afternoon when Joe Clark came out of the Model Garage office into the shop and began picking time-and-material slips out of the old cigar box on the end of the workbench into which his partner Gus Wilson always drops them after he has filled them in.

"Pretty near quitting time," Joe remarked as he glanced over the smudged forms. "Good day, hey? Where's Bill?"

"I let him off an hour early," Gus said. "He's going upstate to visit his folks over the week-end, and he's got a long drive in front of him."

A horn sounded outside, and Joe stuffed the slips into his pocket. "There's some one who wants gas."

Gus glanced toward the open shop door. "No they don't," he said. "They're coming in. It's the Callenders, and they're in trouble again. Wonder what it is this time."

A snappy roadster was driven into the shop, towing a shiny and expensive sedan steered by a portly and plutocratic-looking middle-aged gentleman whose red face and swanky golf clothes were generously smeared with grease and grime.

From the roadster leaned an easy-to-contemplate young woman whose dark eyes showed amusement. "Dad's done something foolish to his car so it won't run and I've had to tow him down here. Incidentally, Mr. Wilson, now I've got myself late for the heaviest date I've had in weeks!" she said, indicating eagerness to be off. "Now you can take care of him," she laughed. "Untie the rope, will you please? I'm going!"

Gus untied the tow rope, and she maneuvered the roadster expertly out of the shop. Callender waited silently until his daughter had departed. Then he climbed out of his sedan, looked at Gus and Joe with a help-me-I'm-lost sort of expression on his florid round face, and shook his head slowly. "I'm licked!" he said briefly.

Joe tried to look politely concerned and mildly disapproving at the same time. Callender is a well-to-do-man who moved to town recently with his three-car family, and who has become an excellent customer of the Model Garage in spite of what Joe Clark considers his reprehensible habit of doing a lot of little car jobs for himself. But that habit doesn't bother Gus Wilson—he soon found that Callender isn't nearly so successful a mechanic as he is a broker, and that most of the little jobs he tackles turn up, often in aggravated form, in the shop to be done over again. "What's the trouble?" he asked, succeeding in smothering a grin.

Callender looked freshly aggrieved. "I can't understand it," he said fretfully. "It's really beyond me. For the past few days this car has been making a most peculiar sort of noise, and this morning it refused to start. I decided that, as I wasn't going down to the city today, I'd find out what was the matter with it. My boy Kenneth—he got high marks for a course in automotive mechanics he completed at school—told me it might be a leaking head gasket. After making various tests, I removed the head of the motor. I found that the piece of copper between the upper and lower parts of the motor — the gasket—was broken in a couple of places. I drove down to the city in my daughter's car and brought back a new gasket.

"I had used meticulous care in taking the motor apart—I had marked each part, and even put labels on some of them, to make certain that I'd get them back in exactly the same positions that they had been in. I reassembled the motor with the same care. And now"—Callender seemed on the verge of tears—"and now the darn car won't start!"

Gus looked more serious than he usually looks when he tackles even a tough trouble-shooting job—as he said afterward, he was afraid that this time Callender had really gummed up the works.

He got into the car and stepped on the starter. The only response was a muffled *cough* from one of the eight cylinders. He got out, raised the hood, took out one of the spark plugs, and examined it carefully. Then he made a quick job of stripping off the engine head. All the plugs were good and wet, and each cylinder contained considerable water.

He gave Callender a queer sort of look. "What gets me," he said, "is where the devil all this water came from!"

"Why," Callender said, "I put it there."

"You *what?*" Gus demanded.

"I put it there," Callender repeated. "I noticed that there was water in the cylinders when I took the head off the motor, so to be sure that everything was exactly as it had been, I poured a little water into each

Next, he took off the rotor and just as carefully checked it for loose or dirty contact between the spring and brush

cylinder before I put the head back on. Nothing wrong about that, was there?"

Joe Clark said that he heard the office phone ringing, and left hurriedly.

Gus's face didn't change. "Being careful backfires on a fellow sometimes," he said diplomatically, and went on to explain how the original gasket had caused the trouble by breaking through at some of the water ducts and allowing water to leak into the cylinders. While he talked he worked—swabbed the water that Callender had so carefully poured into the cylinders out of them, dried the spark plugs thoroughly, and then replaced the engine head. "Try her now," he said when he had finished.

Callender, his face red, stepped on the starter, and the engine took off with a heart-warming *zzing*. "You must think I'm an awful fool," he said.

"No, I don't think that," Gus told him. "It's just that repairing cars isn't your job, any more than buying and selling stocks is mine. I'll let you in on a secret, Mr. Callender. When I started fooling with the market back in the easy-money days I made a bigger mistake than you made when you poured water into those cylinders—and one that cost me a lot more!"

Callender grinned. "I get your point," he said. "After this, any work that has to be done on our cars will come right in here to you."

After Callender had driven out of the shop, Gus glanced at the clock, saw that it was after six, and started to wash up. While he was at it, Joe Clark stuck his head in at the office door. "Say Gus," he said, "a fellow just phoned that his truck is stalled a few blocks down the road, and he wants to know if we'll tow him in and fix him up. Says he's got to get to New Haven tonight or bust. I know it's past quitting time, and that Bill is away, but this driver claims that if he doesn't make his delivery it'll mean holding up a national-defense job, so I thought. . . ."

"You thought right," Gus interrupted. "I'll go get him, of course."

He found the stalled truck—it was a recent model of a popular make—laid out at the side of the road. Its driver withdrew his head from under the raised hood when Gus stopped the wrecker beside him.

"The darned thing just plain quit on me," he growled. "Gasped a couple of times, and then quit cold. It did the same thing this morning, but then it ran all right after a garage fellow had cleaned out the fuel pump. But this time . . ."

"Hop in," Gus told him. "Over in my shop we'll have something to work with."

After towing the truck into the shop, Gus climbed in and stepped on the starter. The engine took hold on the first whirl. "It'll start all right," the driver said discouragingly, "but it won't keep going."

Gus speeded up the engine a little. For perhaps a minute and a half it ran smoothly. Then it gasped. Then it stopped.

Gus tried again. This time, when the engine began to die off, he pulled out the choke and opened the throttle a little. But again the engine stopped. "Acts to me as if it wasn't getting enough gas," he said. "How's your tank?"

"At least three-quarters full," the driver told him.

Gus grunted and lifted the hood. He removed the gas line between the fuel pump and the carburetor. "Step on her," he said. The starter turned the engine over fast. "Switch her off," he instructed after he had satisfied himself that the pump was working efficiently and delivering gas under plenty of pressure.

He checked the carburetor carefully—float level, the high-speed and idling jets, and the choke valve. Everything was in perfect order. He replaced all fittings.

"Start her again," he said. Again the engine took off promptly and ran smoothly—and again after running for over a minute it stopped.

"Must be the distributor," Gus said, more to himself than to the truck driver. He checked the distributor. Its points were clean and correctly spaced. Its bakelite head had clean contacts and showed no cracks.

Gus hummed another tuneless tune. Then he took out the spark plugs and checked each one for its gap and for cracks in its insulation. The gaps didn't need any adjustment, and he couldn't find any cracks.

He replaced the coil and condenser, and then checked the timing. It was perfect!

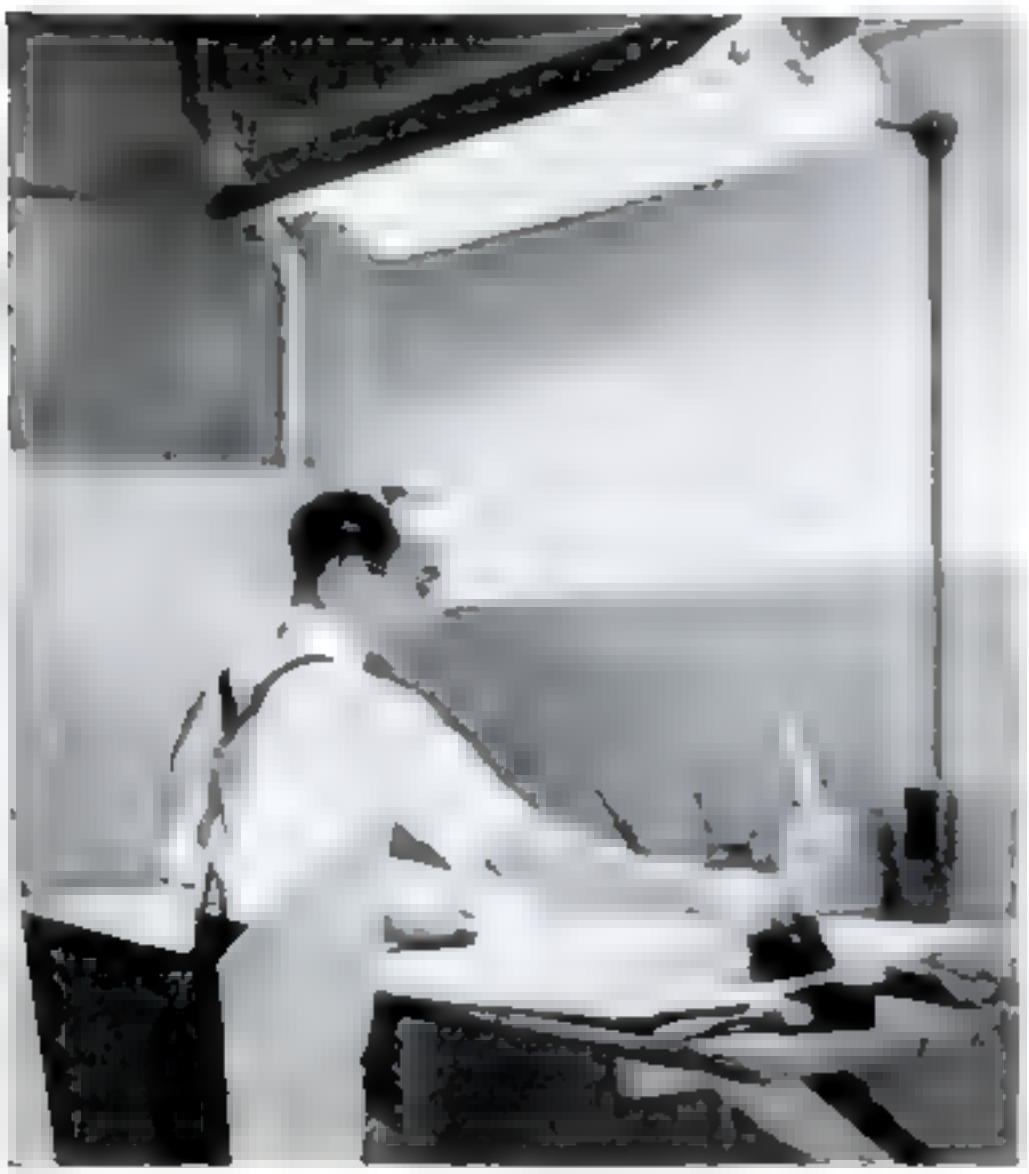
Gus loaded and lighted his pipe. He puffed clouds of gray smoke as he did a job of heavy thinking. Then he shook his head. "It just ain't so!" he decided. *(Continued on page 218)*

GUS SAYS:

Funny thing how cars seem to drive a lot easier in warmer weather. Maybe that's why a lot of drivers neglect changing their oil and getting regular grease jobs in the summer months. They don't save any money that way, believe me!


HOME and WORKSHOP

New Finishes for Fir Plywood AND Knotty Pine



A fluorescent fixture, if available, gives an unchanging light for matching and blending colors on plywood panels

By

RALPH G. WARING

ARCHITECTS, master painters, home owners, and amateur craftsmen have all joined in asking for simple, durable, and attractive finishes for plywood and knotty pine. Many of them also want to know how to obtain bleached or blond effects comparable with modern furniture finishes. The need for such finishes is especially felt in basement recreation or "rumpus" rooms, because these rooms rarely have sufficient window lighting, and the general finish should therefore be light in tone.

Price considerations often require the use of the cheaper plywoods, such as rotary-cut Douglas fir, which in many sections can be bought in three-ply stock, good on

This recreation room is paneled with inexpensive Douglas-fir plywood and trimmed with bamboo. The game room illustrated on the facing page is also paneled with Douglas fir and treated with a Cayuga sand finish. The moldings are finished in high-gloss scarlet enamel. In the average home, however, it is better to be more conservative and use wood moldings of harmonizing rather than contrasting color

one face, for five cents a square foot. Such material is often beautifully figured, but finishing difficulties in many cases have prevented the use of this otherwise valuable wall board. Its heavy, conspicuous grain of hard summer wood and very soft spring wood is difficult to stain and finish in soft tones, free from bizarre figures caused by uneven stain penetration.

Since the recent introduction of what are called "wood preservative" or "penetrating" finishes, however, a new technique of color

PRESERVATIVE FINISH—Natural [PAINTING]

1. Sand panel with 4/0 garnet paper. Rub with the grain in straight lines only.
2. Brush on clear wood preservative. (This type of finish is made by various companies and is sometimes called "penetrating floor finish" or "floor seal.") Dry 45 minutes.
3. Rub clean with 00 steel-wool pads to a bright, even surface.
4. Dry 24 hours at 70 deg. F.
5. Recoat lightly. Dry 15 minutes. Rag off clean.
6. Dry 12 hours.
7. Steel-wool wherever necessary for even sheen and soft feel.
8. Wax. Dry 10 minutes. Polish with rags, brush, or flexible-shaft equipment with lamb's-wool pad. Do not use self-polishing waxes unless previously tried out on a completely finished sample panel.

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PRESERVATIVE FINISH—Cayuga Sand [PAINTING]

(FOR BLOND EFFECTS ON DOUGLAS-FIR PLYWOOD AND OTHER PANELS)

1. Sand with 4/0 garnet.
2. Mix one part ivory or cream eggshell wall enamel with one part of clear wood preservative. Brush or spray on a light, even coat so that wood grain is subdued but not covered. If brushed, use a dry, wide wall brush to blend the coating gently *in continuous straight lines* the entire length of the panel. Wipe bristles quickly at end of each stroke to keep them dry and clean. Work with tips of bristles only and use no pressure. Dry 24 hours.
3. Use 2/0 steel-wool pads to secure the final even tone.
4. Wax. Dry 15 minutes. Polish.

If color is desired, use glazing colors as for Quaker gray or autumn green (or use walnut or mahogany) and blend out soft and evenly. First work out a sample panel on the back, keep a record and check the results. A glazing liquid for colors over Cayuga sand is mixed as follows: flat varnish, 4 oz.; boiled linseed oil, 2 oz.; pure turpentine, 1 oz. Buy artists' tube colors, thin out small amounts in separate cans with brushes, apply in small areas as needed, and blend out immediately with rags or dry 2" brushes. Have a separate rag or brush for each color

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application has made it possible for anyone to finish this type of fir plywood in beautiful, even colors, suited to the most exacting tastes. These finishes, which are often sold under names such as "penetrating floor finish" or "floor seal," almost without exception have tung oil or China-wood oil as their base material—the most waterproof vegetable oil in existence. When combined with various resins, and in some cases with waxes, it produces a film that actually penetrates the pores of the wood and acts as a sealer. It can be applied with a brush, rag, mop, sponge, or spray. The coat is left a definite length of time, then rubbed off the surface with rags or steel wool, allowed to dry, recoated, again rubbed off, and finally waxed, if desired.

A number of firms, including some of the better known paint companies, are now making these finishes. The prices range as a rule from about $3.10 to $4 a gallon. The finishes can be obtained colored as well as clear, but the clear type is used in the accompanying specifications.

The durability of the new finishes almost surpasses belief. One test panel, a small section of which is illustrated, was given the standard stroke-machine test with a 2" belt faced with No. 00 garnet abrasive paper. After 300,000 strokes it was difficult to find any trace of wear.

Many contractors and builders and practically all amateur woodworkers make it a practice to erect the studding and other framework, then fasten on the panels with nails or self-bonding glues, and finally finish the entire wall areas as standing work. Time may be saved and a much better result obtained by carrying on the finishing process separately at the same time the carpenter work is being done. For the home craftsman this method is of distinct advantage since he can finish a few panels at a time in the evenings.

Applying clear wood preservative to plywood. It is always desirable to finish the wood before erection, if possible—a good method for those who wish to finish a few panels at a time

PRESERVATIVE FINISH—Autumn Green [*PAINTING*]

1. Sand with 4/0 garnet paper.
2. Mix: 1 pt. soft-brown four-hour enamel, 1½ pt. natural wood filler, and 1½ pt. turpentine. Also mix: 1 pt. jade-green enamel, 1½ pt. natural wood filler, and 1½ pt. turpentine.
3. Brush on each color in various hand-sized areas, leaving many open portions between to show natural wood. Blend each color with rags to give cloud effects devoid of sharp margins. The color values should grade from heavy at the bottom to quite light at the top in order to give color balance in the room itself.
4. As soon as colors are wiped off, coat in the entire panel with clear wood preservative; then use rags and 2/0 steel-wool pads to secure desired blend and weight of colors. Keep best panel as a master panel against which to check all subsequent matching and blending. Dry 45 minutes.
5. Steel-wool clean and bright. Dry 24 hours.
6. Recoat lightly with wood preservative. Dry 15 minutes. Rag off clean.
7. Dry 12 hours.
8. Wax. Dry 10 minutes. Polish.

Note: By following the same specifications but using gray tan green and the natural wood a four-color blend called "forest" or "chromewald" can be obtained. Keep the colors soft and subdued, in clouds rather than in heavy areas, which would give a spotty effect.

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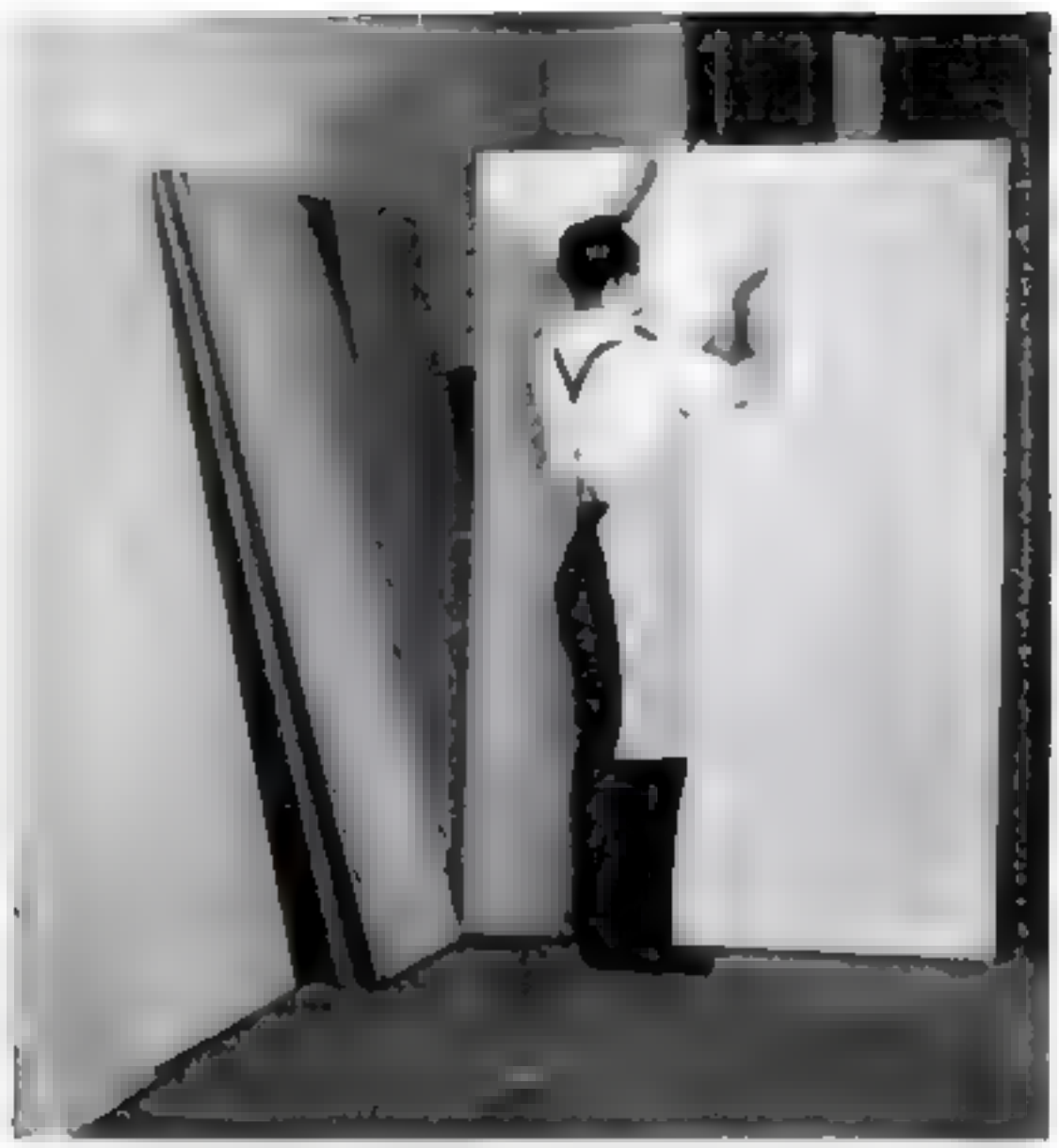
The wall areas should be carefully measured and the panel spaces numbered in rotation so that the panels may be selected and matched for color and grain figure. Pick out the choicest panels for the positions where they will be displayed to the best advantage.

A visit should be made to the lumber dealer, and a study made of the type of figure best suited to the room in question. Some runs of veneer give bold, heavy effects, some have finely balanced center-grain designs, and others show an even, lacy effect over the entire surface. The thoughtful architect or owner can thus assure definite decorative effects that would be lost if the panels were chosen at random. As a rule the dealer will be only too glad to sort a reasonable number of panels from stock in order to satisfy a customer who is buying a reasonable quantity.

When the panels have been delivered, the final selections should be made and an identifying number marked on the poor face of each panel (indicated by the dealer's stamp or by knots or other defects). Panels to be viewed from both sides must, of course, be chosen from stock made up with two good faces, but wall stock requires only one face to be of selected veneer.

The next step is to decide upon the schedule of finishing. If fir is to be used, bleaching with commercial bleaches is not needed for blond effects and should not be attempted.

Unretouched photograph of part of a cheap grade of Douglas-fir plywood panel which had been given a preservative finish and then subjected to 300,000 strokes of a 2" belt faced with No. 00 garnet abrasive paper in a continuous machine test—more wear than any wall would get in years of use



To insure the best appearance, it is desirable to select and match the panels for color and grain figure. All are then numbered in the order they are to be erected around the room

On woods like maple, birch, or basswood, which can also be used in this work, bleaches may be used if desired. The reason bleaching is not desirable on Douglas fir is that the grain becomes excessively raised, and a disproportionate amount of hard sanding is required to reduce the grain to a level surface. This will inevitably cut below the bleach penetration, so the effort is entirely wasted.

Blond or bleached effects on Douglas fir may be obtained by some modification of the accompanying specification for a Cayuga sand finish. The grain is partially subdued and may be sanded or steel-wooled to secure any final effect desired with the least labor or any of the specifications listed. The finish, applied as far as the third step, may also be used as a *first* sealer coat and followed by color-glazing in walnut, mahogany, or other colors to produce wall panels in the finest of Tiffany glazes—a finish well suited to recreation and similar rooms.

After the finishing schedules are complete on all panels, they can be erected according to their numbers and fastened in place with rosin-coated nails at the edges and with self-bonding glue on the center studs so as to avoid any holes in the center areas. Such holes would require putty glazing, which is entirely unnecessary with modern erection methods.

Those readers who are unfamiliar with the glued type of construction will find it a

PRESERVATIVE FINISH—Quaker Gray [PAINTING]

1. Sand with 4/0 garnet paper.
2. Mix. 1 qt. gray four-hour enamel, 3 pt. natural wood filler, and 3 pt. turpentine.
3. Brush on entire panel. Rag off quickly.
4. Apply wood preservative coat immediately and blend color with rags for even tone or cloudy effect, as desired.
5. Dry 45 minutes. Steel-wool clean and bright. Watch color.
6. Dry 24 hours after blending and using 2/0 steel wool.
7. Recoat with wood preservative. Dry 15 minutes. Rag clean and bright.
8. Dry 12 hours.
9. Wax. Dry 10 minutes. Polish.

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great improvement over nailing. Suitable self-bonding glues of the heavy casein type are supplied by large dealers in Douglas fir plywood, but any heavy-bodied casein glue may be used. Some of the dealers also have glue guns that may be rented. These are similar to the caulking guns used for applying flexible caulking material around windows. The glue can also be applied with a 1½" brush, but a gun saves considerable time.

Some provision must be made for applying pressure to each panel within ten minutes after gluing. This can be done by using two by fours and wedges or a jack, or with nailing strips, which are nailed at 6" intervals and left on for about four hours before being removed. Where panels are to be finished without nails, the pressure jig is left on merely for as long a time as is found necessary for the glue to set; this depends upon the temperature and humidity.

The glued construction is much more rigid than the ordinary method of using nails; in fact, there is about as much difference as between the modern welded all-steel automobile body and the early bolted and riveted body.

What type of moldings to use for hiding the joints is, of course, a matter of personal preference. Metal-covered strips in various finishes are sometimes chosen to give a smart, modern appearance, but properly designed wooden moldings, finished in a harmonizing rather than a contrasting color, are more satisfactory for most purposes. They give a subdued accent that is more pleasing in the average room than the darker linings that are so frequently employed. One or two preliminary coats of finish may be given these moldings, and after erection all brad holes should be glazed so that the final coat will produce the selected finish.

The home worker who has a well-equipped shop, especially if he is fortunate enough to have a fluorescent lighting fixture, can do the color work on the panels in the evenings even better than under failing daylight conditions. With a master color panel always before him for checking and comparison, he can obtain uniformity of treatment and color. The white fluorescent tubes produce a constant and unchanging light value, and such a fixture will soon compensate for its apparently high initial cost.

Knotty pine, as specified by architects for libraries or large rest rooms, continues to be finished in a soft, dusty, amber tone such as might be found on a very old piece of long-used and much-waxed natural white pine. It is suggested, however, that a modification may be obtained by using the Cayuga-sand specification as a first coat and then blending out with steel wool and wood preservative as a second coat. This offers a new, light, and distinctive effect that is entirely in harmony with modern furniture ensembles. A mild use of subdued forest colors in tans, grays, and greens as glazes would also enhance this use of knotty pine.

The accompanying specifications are offered as working guides for the new finishes and may be modified to produce almost unlimited color effects just so long as the fundamentals are retained.

PRESERVATIVE FINISH FOR KNOTTY PINE [*PAINTING*]

1. Sand with 4/0 garnet paper.
2. Stain with turpentine asphaltum, ½ pt.; turpentine, 1½ pt.; gasoline, 3 qt. The color is controlled by using more or less asphaltum, but work up a large sample piece with this complete finishing schedule before judging color.
3. Dry 24 hours.
4. Brush on clear wood preservative. Dry 45 minutes.
5. Steel-wool clean and bright. Avoid cutting through the color.
6. Dry 24 hours.
7. Recoat lightly. Dry 15 minutes. Wipe clean.
8. Dry 12 hours.
9. Wax. Dry 15 minutes. Polish.

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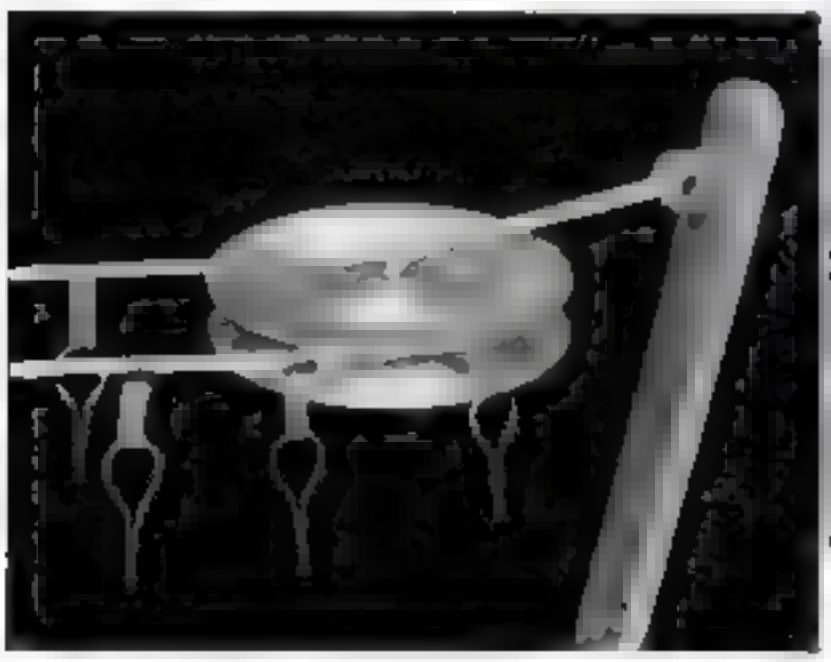
IDEAS for HOME OWNERS

AIR-CONDITIONING UNITS that could be used in small houses at small cost would add luxury to life in many homes. Here's one that its inventor, Thomas W. Carraway, thinks is ideal for such use. Designed to sell for about $300, it employs a re-evaporation system to keep humidity down while cooling the air. At the right is a model of the outfit, prepared for display at the last Inventor's Convention in Dallas, Texas. A working unit of this machine would measure six by four by four feet, and could be installed at a convenient central point.

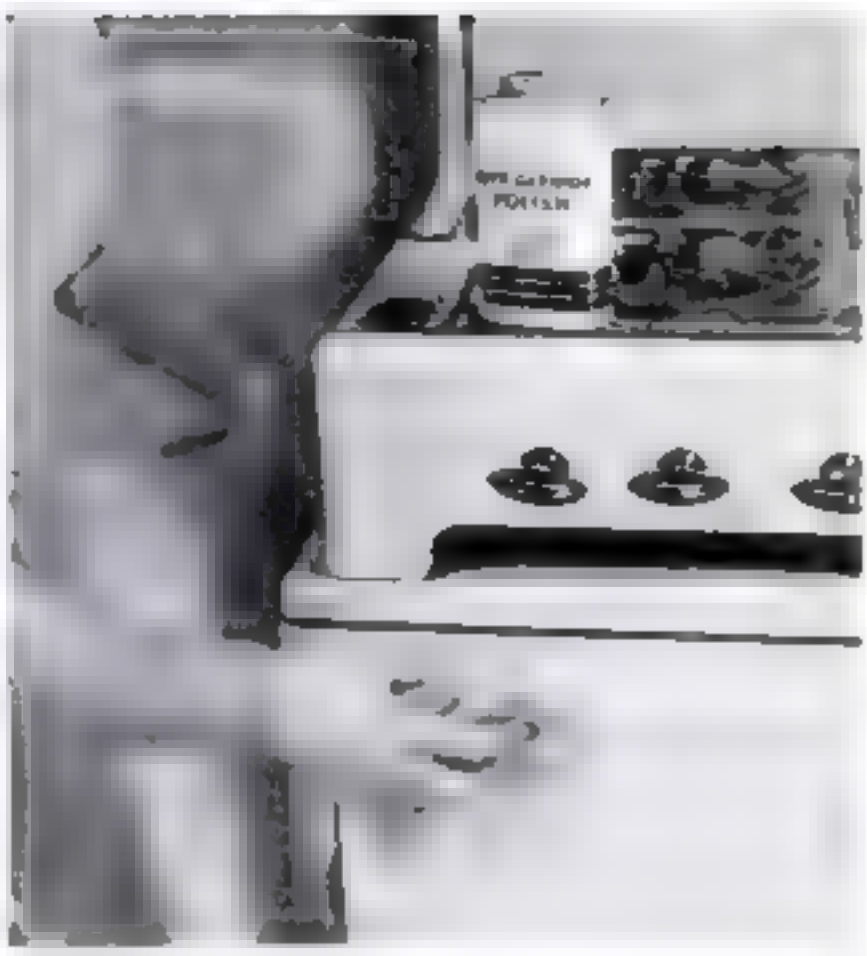
Inventor Thomas W. Carraway demonstrates a model of an air-conditioning unit for use in small homes

BENDING STEEL TUBES where they project through walls or floors is often a difficult job. To aid plumbers in overcoming the difficulties of such work, a tool has been developed which can be set right up against the surface through which the tube projects. It consists of a clamp which fits around the tube and holds against it a curved channel over which the tube can be bent to any desired angle without danger of buckling. This curved piece is fitted with a long handle which can be set at any angle so that it can be braced against a solid surface. A notched joint between the parts locks them instantly in the desired position.

ENDLESS CLOTHESLINE. Pulleys with supporting brackets on only one side permit clothes to be moved to any point on this line without taking them down. They also make it possible to remove a single piece of washing from a point at one end of the line without disturbing others, and to use both sides of the line. Clips are used instead of clothespins.

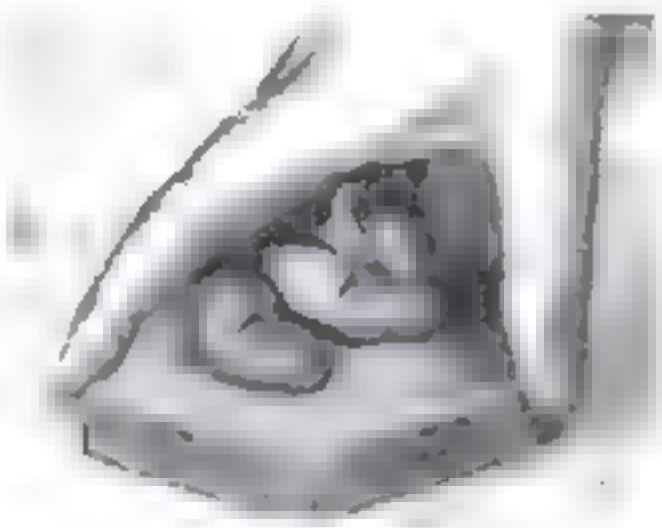


Special clips and pulleys enable any piece of wash to be removed from this line without disturbing the rest



KEEPING THE KITCHEN neat and shiny is made easier with a liquid refrigerator polish now available for cleaning and waxing white-enameled surfaces. Working in much the same manner as certain types of auto polish, it removes finger prints and unsightly films with a little rubbing, and at the same time deposits a glossy coat of wax on the surface to protect it from further accumulations of dirt and stains. It also can be used on silver, chromium, and nickel finishes, as on bathroom fixtures, table accessories, and the like.

FINDING A PLACE to put your paintbrush when you want to stop painting for a few moments is no problem at all when this combination can and paintbrush holder is used. It clips on the side of the paint container to form a handle for the can, and its upper end is formed into a clip to hold the brush handle. It is sold in sizes to fit ½-pint, pint, and quart cans. A "wiping bar," which clips into the top of the can for wiping excess paint off the brush, is provided with the holder, and returns to the can paint that would ordinarily be wasted. Both the wiping bar and handle are instantly detachable.

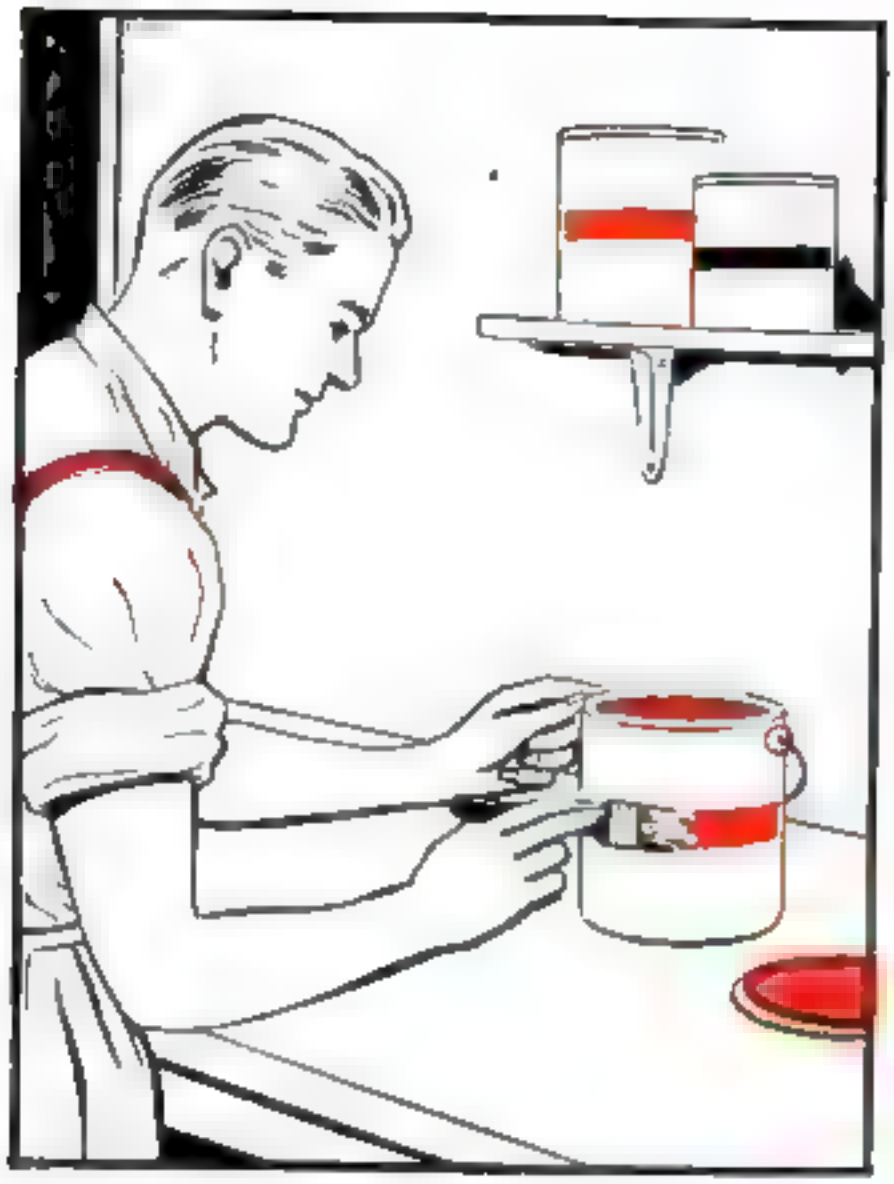


WORKMEN who like to sharpen their tools frequently but don't want the bother of carrying a bulky stone should welcome the pocket sharpener shown at the left. It is only 1/16" thick, ⅞" wide, and 4¾" long, and so flexible that it can be bent almost double without injuring its sharpening surface. Its size and flexibility make it ideal for carrying in a pocket or wallet. Sportsmen, model makers, and wood carvers will find it convenient.

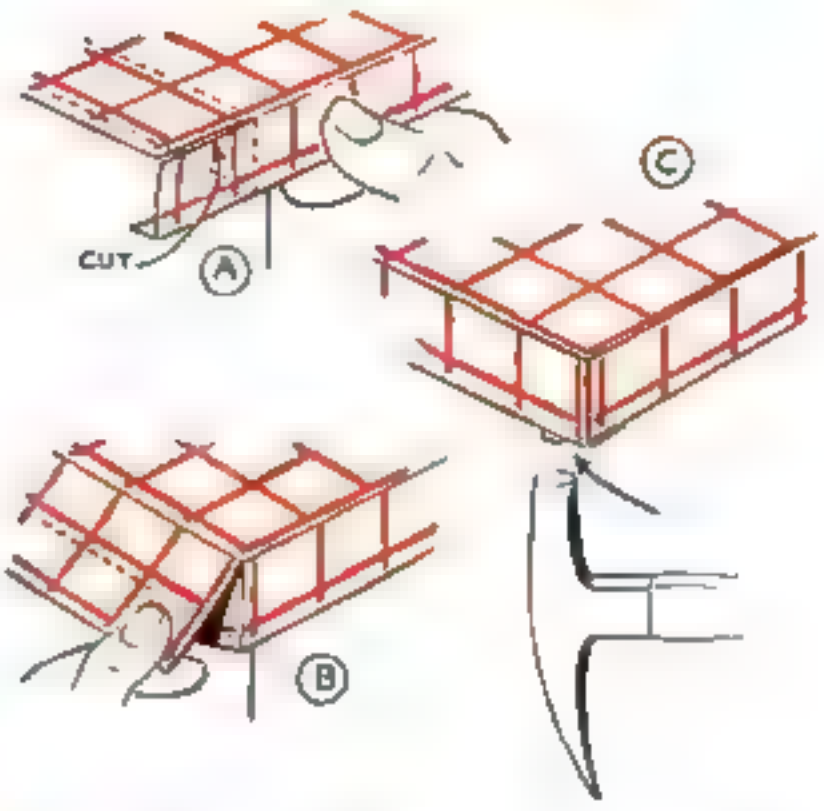
Made of a new synthetic composition, this thin pocket stone is quite flexible

GARDEN HOSE that weighs only eight pounds for each 50 feet of length, including couplings, has been developed for use where standard-size hose might prove cumbersome. When attached to a spray nozzle or sprinkler, it carries from 65 to 75 percent as much water as the conventional size at average faucet pressure. Women and even children can handle it easily.

KEEPING

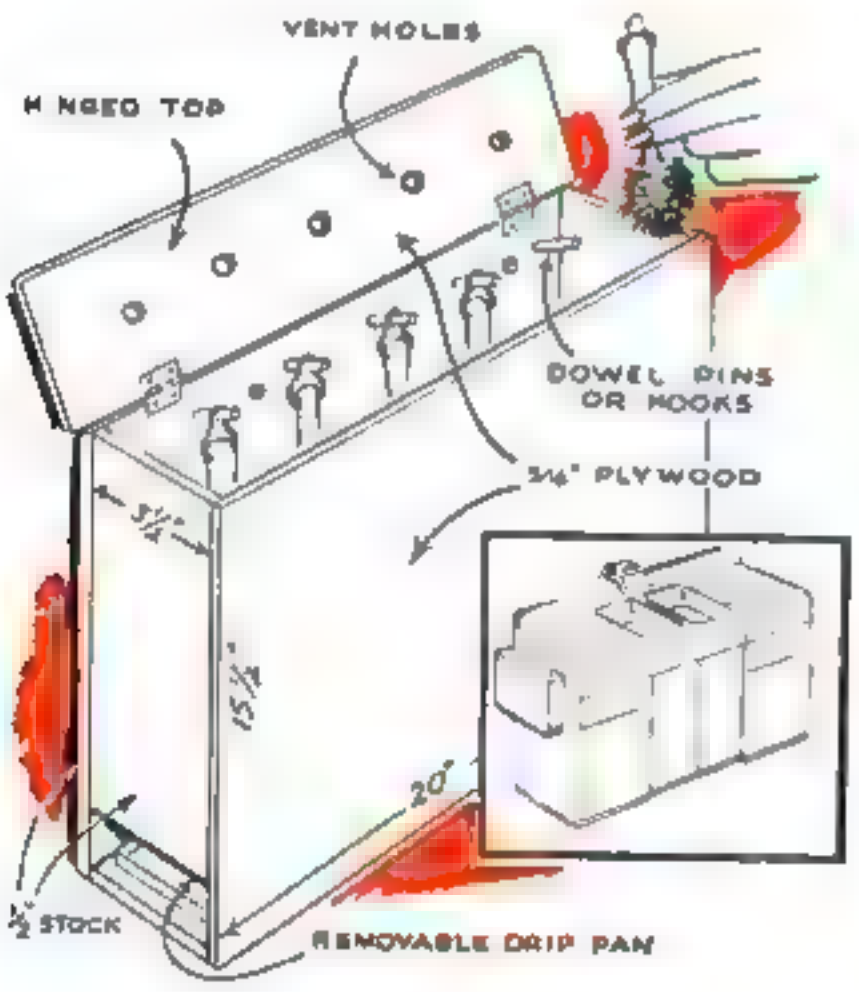


SOME PAINTS, WHEN APPLIED, will dry to a different shade than they appear to be in the can. Painting a band of the color around the container will identify it upon the shelf and provide a permanent color sample for reference and comparison



TO PRODUCE NEAT CORNERS when covering a table with oilcloth or other fabric, fold over one edge and slit the material as above. Tuck one edge behind the other. Fasten with tacks from beneath

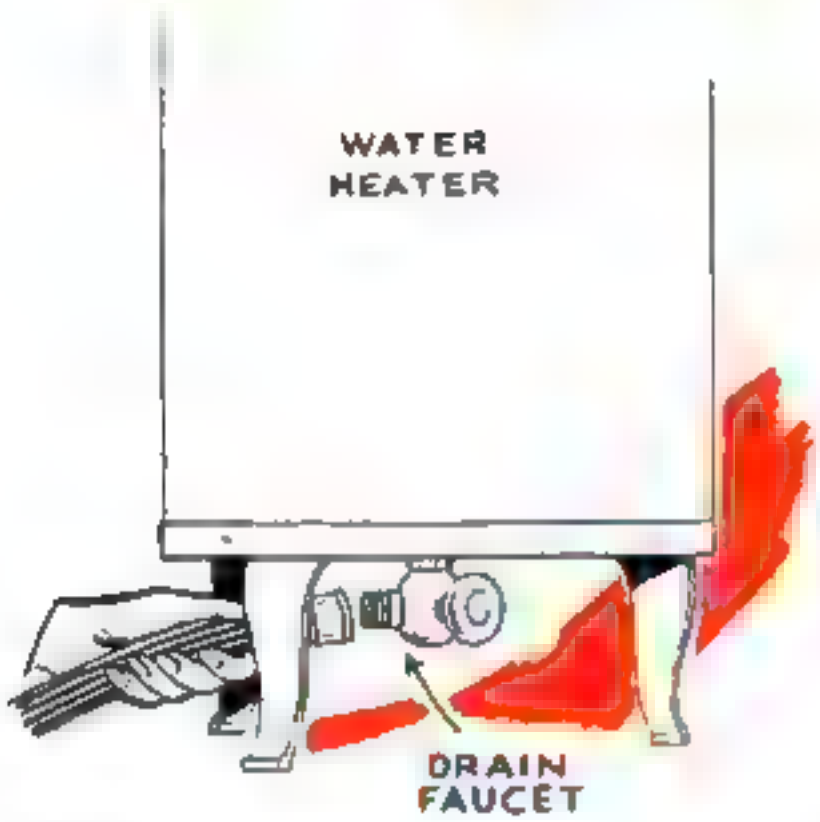
LEAD-COVERED ELECTRICAL WIRE, nailed to a wall or other flat surface so as to leave loops as shown above, forms convenient holders for mops, brooms, garden tools, and other household articles



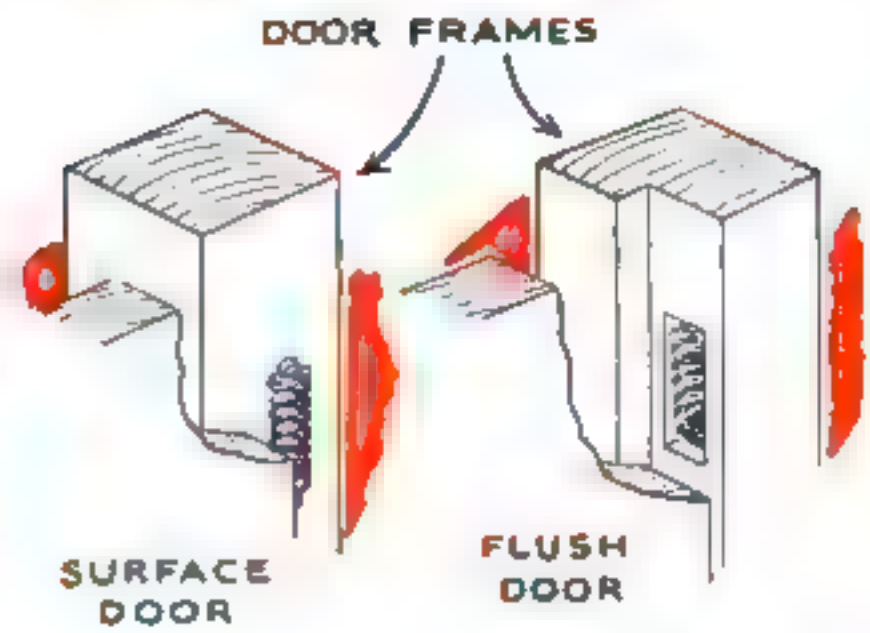
THIS VENTILATED CABINET keeps dish mops, scrapers, sink brushes, and the like out of sight yet within easy reach, and allows them to dry thoroughly. Paint to suit and fasten alongside the sink

LOOSE PHONOGRAPH RECORDS can be carried safely in a portable-typewriter case. Fill up the bottom with cardboard to the height of any catches or hooks. Most cases will hold twelve-inch records

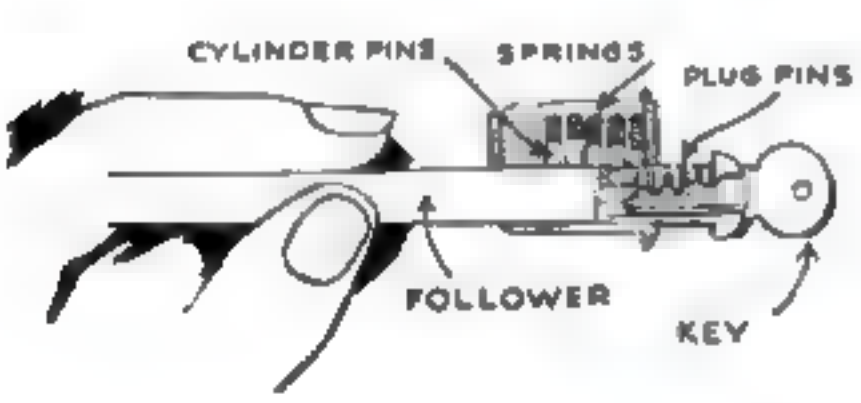
THE HOME SHOP SHARP



IN CASE OF FIRE in the basement, should there be no other supply tap nearby, connect the garden hose to the drain faucet of the water heater. Having water readily available may save the day



SHORT COIL SPRINGS make effective friction catches where appearance is not of first importance. On doors which close flush with the frame, the spring should be fastened with screws inside a mortise cut into the rabbet. On a nonrabbeted frame, it is necessary only to fasten a short spring to that face against which the door closes



WHEN REPLACING WORN PLUG PINS in a pin tumbler lock, keep cylinder pins in place by using a piece of tubing or rolled-up sheet metal to push the plug out. Turn plug slightly for easy removal

A LARGE, EMPTY ADHESIVE-TAPE CONTAINER will serve as a convenient dispenser for absorbent cotton. Keep the contents clean by opening container only enough to take out what is needed

WHEN NO HOT PAD IS AVAILABLE, hot utensils may be set upon a loop of the asbestos-covered connecting cord of an electric table stove, but this should be done only as a temporary expedient

Fig. 1. A fireplace setting like this is a delightful spot in which to entertain guests

Outdoor Fireplaces

THREE LARGE AND TWO SMALL DESIGNS BY CARL T. SIGMAN AND WILLIAM J. WARD, JR.

WHY not go picnicking in your own back yard? Outdoor suppers are a delightful variation from more prosaic modes of entertaining, and one that guests and hosts alike enjoy. Charcoal-broiled steak, served around the glowing embers of an open fireplace, has a flavor few can resist, especially when appetites have been whetted by the fresh air and the piquant aroma of food cooking over live coals. The evening meal, too, is doubly enjoyable when eaten in the quiet of the garden during the long summer twilight.

A fireplace in the garden makes it possible for these occasions to be largely impromptu, eliminating the delays, long preparation, and fatigue of conventional picnicking, as well as the journey home after the day's fun is over.

The choice of a fireplace must be governed

more or less by its intended location. A corner of the garden may be a likely spot for one such as shown in Fig. 1. Fireplaces built against a dwelling, as in Fig. 2, may make use of the house chimney, provided that proper dampers are installed. If a separate chimney is built, it should rise at least two feet above the ridge of the nearest roof. A lesser height will result in down drafts that will blow smoke back through the fire box.

When at all possible the fireplace should face prevailing winds. If this is not feasible, the chimney should be similar to the one shown in Fig 1, with openings front and back, which will induce a satisfactory draft by suction. Avoid a location close to trees. Not only are these likely to be damaged by the heat, but they occasionally cause troublesome down drafts.

Some communities have rather stringent fire laws governing the use of outdoor fireplaces. Ordinances may require that the permission of neighbors be obtained. It is therefore advisable, before going to any trouble or expense, to consult the authorities concerned. Local regulations may require installation of a spark arrester, such as shown in Fig. 1 and Fig. 6, and this is an advisable precaution to take in any case in order to safeguard near-by trees, shingle roofs, and the like.

The style of the fireplace and its con-

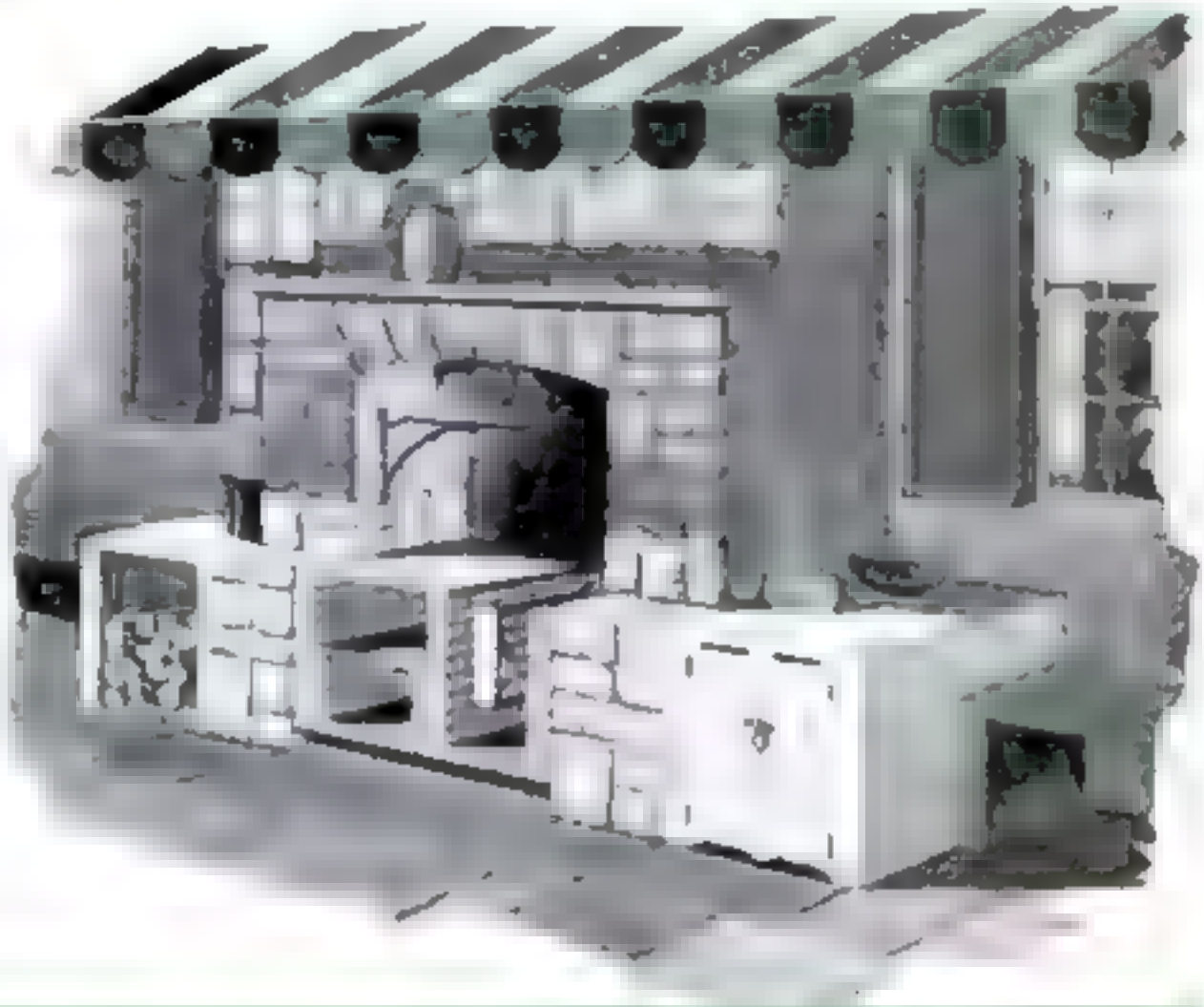


Fig 2 Built against the projecting breast of an exterior house wall, this fireplace requires no separate chimney A wood grate and charcoal steak broiler are shown in the plans

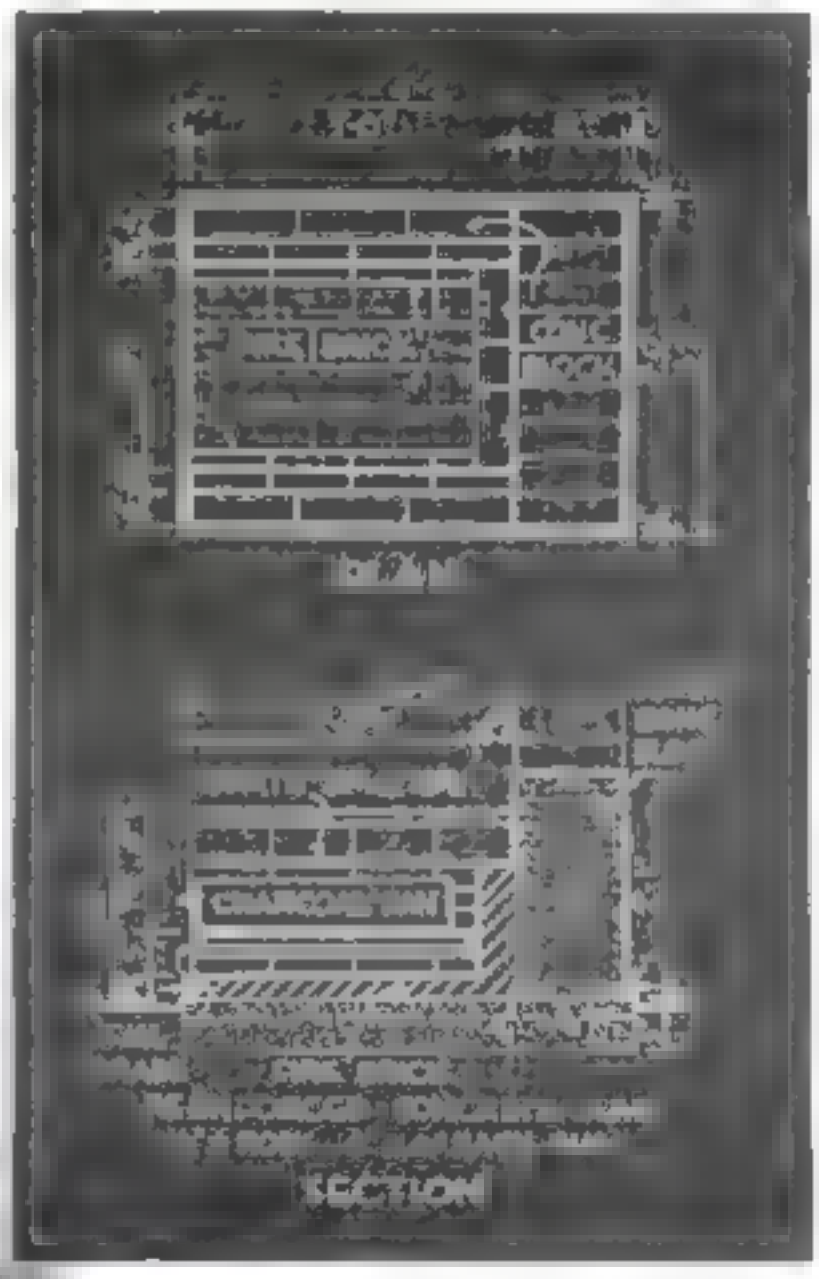
struction should by all means harmonize with the type of architecture prevailing in the neighborhood. Rustic fireplaces are ideal in rustic settings, but formal brick or stone designs are more appropriate to conventional surroundings.

Brick, concrete, concrete block or stone may be used, but stone must be carefully selected because not all types will withstand severe heat. The shales, limestone, and sandstone are to be avoided, for they may chip or explode when exposed to fire; and as they absorb water, they are even more likely to do so if subjected to heat while wet. However, granite or other unstratified rock is quite suitable, and even porous stone may be used if the fire box is lined with fire brick. Such lining should also be installed if the fireplace is made of concrete block or common brick.

The dimensions shown in the accompanying drawings are based upon the use of fire brick 2½" by 4½" by 9", but standard sizes vary in different localities, and firebox proportions may have to be altered to suit the size of brick obtainable. The same holds true for concrete block, which may not be locally available in the size specified in Fig. 3.

The fireplace shown in Fig 1 is especially suitable for the corner of a garden wall. No fire-brick lining is provided for in this design, and for that reason fire-resistant rock must be used. All four chimney openings are fitted with spark arresters made of hardware cloth (wire mesh). The sides of the fire box are built with ledges upon which the grates rest, and the upper grate may be pulled forward for conveniently placing and turning food, or removed entirely when no cooking is to be done but a roaring, companionable blaze is wanted. Cooking utensils may be kept in the triangular cabinets flanking the fireplace. The space under the benches is convenient for storing fuel.

A fireplace built against the projecting breast of a house chimney is shown in Fig 2. It is, of course, necessary to make an opening in the chimney, and care must be taken to close the damper of the indoor fireplace before kindling a fire in the one outdoors. A fire-brick lining is specified. The design provides for a broiling grate, to be heated with wood, and, to one side, a duplex charcoal steak grill, anchored in the masonry. The crane shown will be found convenient for making stews. Cooking equipment may be kept under lock and key in



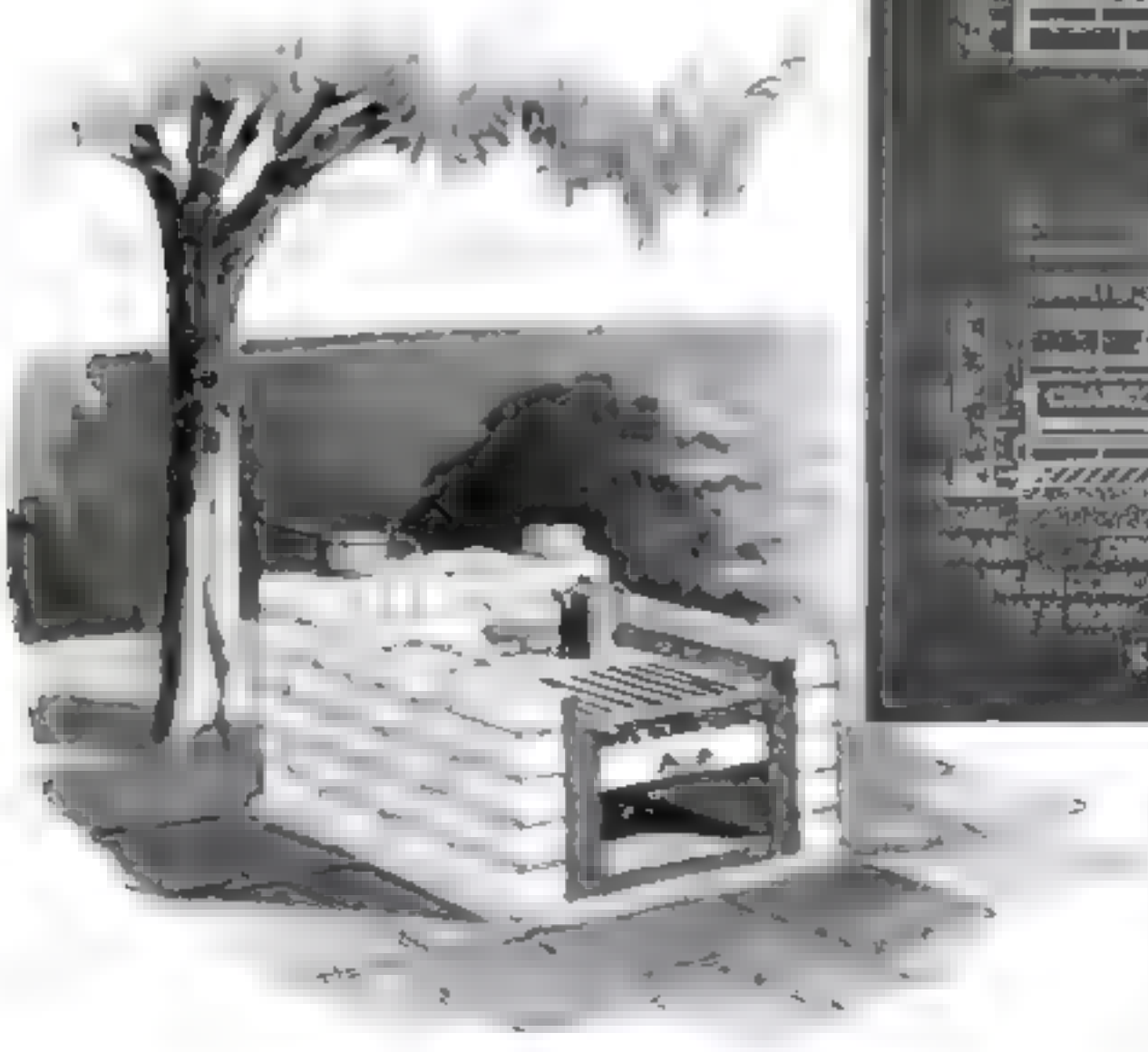


Fig. 3. Concrete block is the material specified for this simple but efficient fireplace, in which a wood grate might be used instead of the charcoal pan shown. The combination top grills and cooks at the same time

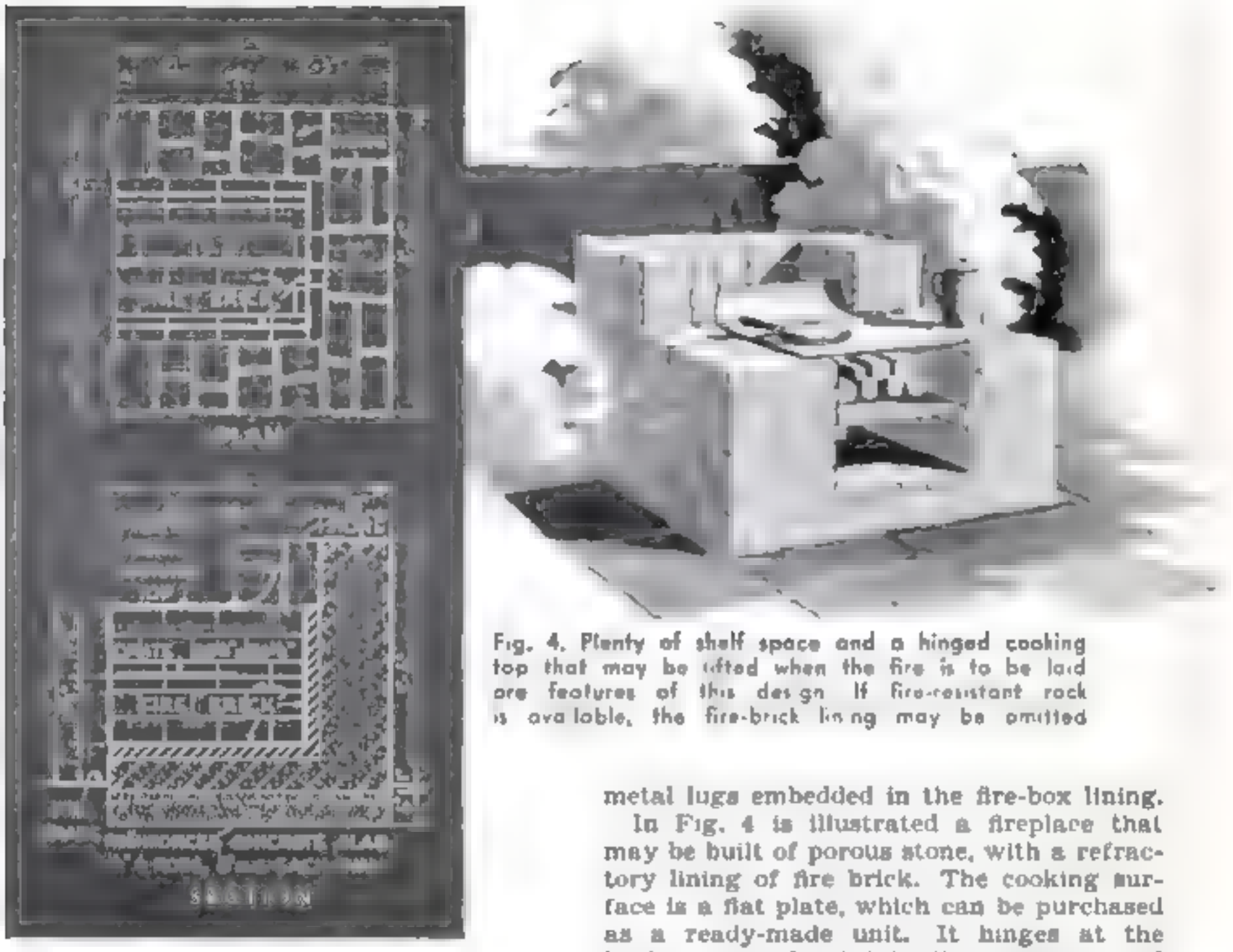


Fig. 4. Plenty of shelf space and a hinged cooking top that may be lifted when the fire is to be laid are features of this design. If fire-resistant rock is available, the fire-brick lining may be omitted

the cabinet at the right. Desirable counter space is provided by the tops of the cabinet and the fuel bin, and by two projecting ledges of the fireplace proper, which should, of course, be built of the same material as the house chimney.

An example of the use of concrete block is shown in Fig. 3. Blocks 4" by 4" by 12" are specified in this design, but if this size is not obtainable the proportions may have to be altered somewhat. The fire box must be lined with fire brick, which may be laid face-to-face or edge-to-edge, the latter method requiring fewer bricks and reducing the size of the fire box less. A raised back provides shelf space for utensils. The combination grill and flat plate shown permits of both cooking and broiling at the same time. Although a charcoal pan is specified, a grate for burning wood may be substituted, but should be placed somewhat lower. A charcoal fire should be about 4" to 6", a wood fire 8" to 10", below the cooking surface. Although the fire could be built directly upon the floor of the fire box, a grate raised 4" above the floor will insure a much better draft through the fire from beneath. In this design both grates are supported by metal lugs embedded in the fire-box lining.

In Fig. 4 is illustrated a fireplace that may be built of porous stone, with a refractory lining of fire brick. The cooking surface is a flat plate, which can be purchased as a ready-made unit. It hinges at the back on a rod set into the masonry, and may be tilted up when the fire is being laid, making it unnecessary to stoop. Many experienced outdoor chefs prefer such a flat plate to an open grill. The fire-box lining is laid with two projecting courses of fire brick, upon which the wood grate rests. Broad shelves afford plenty of convenient space for utensils and other cooking equipment.

The barbecue spit and fire-box unit shown in Fig. 6 may be purchased ready-made, or the design may be altered by using an open fire box such as shown in Figs. 3 and 4. The sink, with its gooseneck tap, eliminates the necessity of carrying water. Flagstones, slate, tile, or even wood may be used for the top of the cabinet and the counter space around the sink. The chimney is fitted with a spark arrester.

A proper foundation for the masonry is the first thing to be considered in planning a fireplace. For small ones in mild climates, a 6" thick "floating" mat or slab of reënforced concrete, poured over a well-tamped base of cinders or sand from 2" to 4" deep, will suffice. This concrete slab should extend 4" below the ground and 2" above, and should be reënforced with 6" galvanized wire mesh, from 10 to 16 gauge,

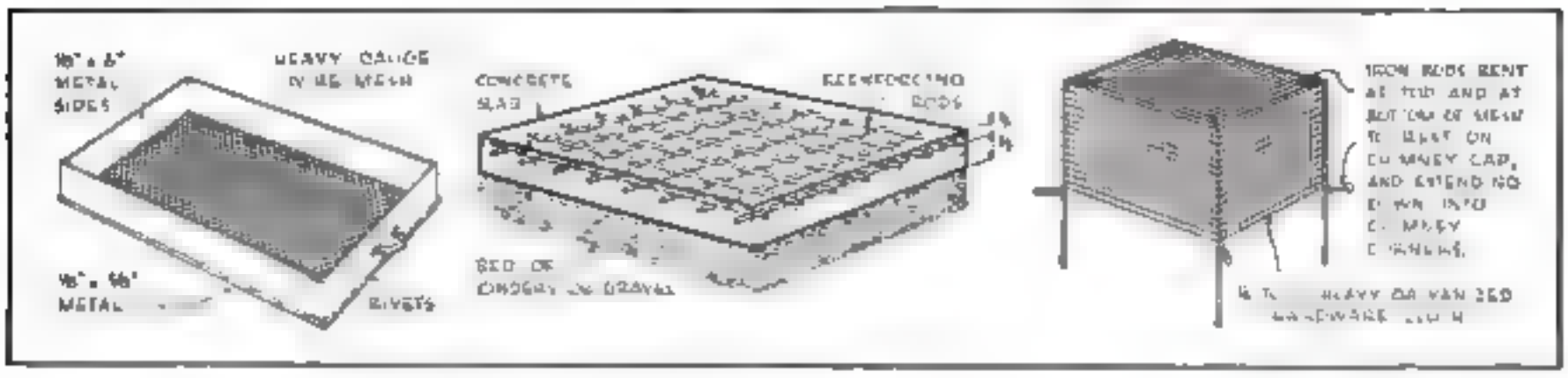


Fig. 5. How to build a charcoal pan is shown at the left. Concrete foundations prevent settling and cracking of masonry. Make spark arresters of iron rod and galvanized hardware cloth, as at the right

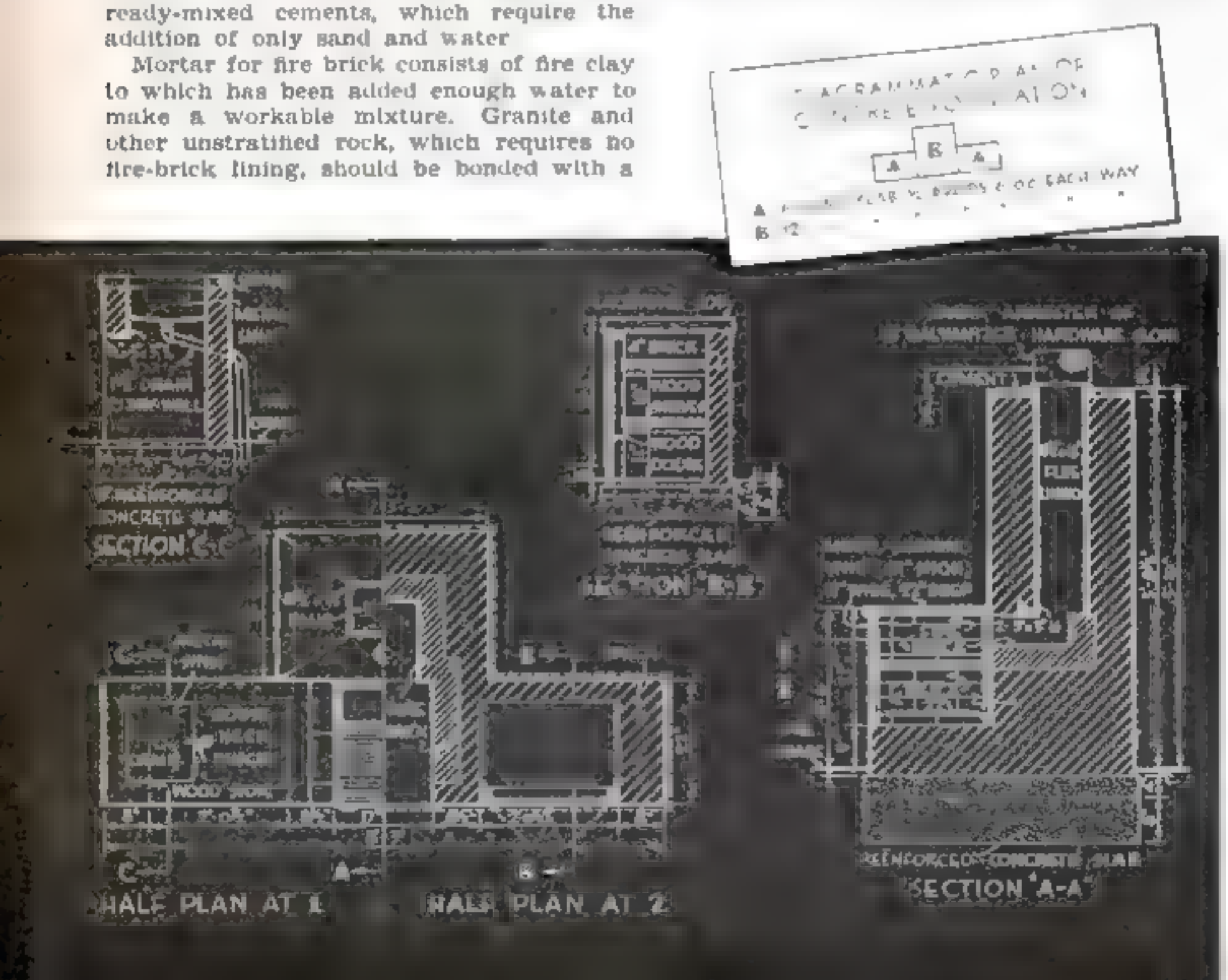
or with ¼" to ⅓" steel rods laid checkerboard fashion, about one third of the thickness of the slab from the top. One part of cement to 2½ parts of clean sand and 4 parts of gravel is a good mix for foundations.

For heavy fireplaces, or in localities where the ground freezes deeply, concrete footings should be used. These ought to be at least 10" deep, or, preferably, deep enough to extend below the frost line.

A good mortar for ordinary brick and concrete block may be made by mixing one part of cement with three parts of clean, hard sand, and adding from 10 to 15 percent as much lime as cement. Use only enough water to make the mortar work easily. Some building-supply dealers offer ready-mixed cements, which require the addition of only sand and water

Mortar for fire brick consists of fire clay to which has been added enough water to make a workable mixture. Granite and other unstratified rock, which requires no fire-brick lining, should be bonded with a mortar made of equal parts of cement and fire clay. This mix should also be used for nonrefractory masonry directly behind fire brick, which is subjected to a certain amount of heat. Joints in brick and stone masonry should not be wider than ½". Joints in fire brick should be as narrow as possible—that is, 1/16" or less. Soaking ordinary brick in water before laying produces a better bond.

Chimneys should be no higher than necessary, although as mentioned before they should rise at least two feet above nearby structures to avoid the possibility of down drafts. Smooth flues make for a good draft. Terra-cotta linings are desirable in this respect. The cross section of the flue should be at least one tenth as large as the com-



bined areas of fire box and ash pit. For an open-front fireplace this proportion should be one eighth.

There are a number of good grates, angles, grills and supporting lugs on the market, as well as complete barbecue units and spits, so that the necessity for improvising such equipment is not so great as it once was. Such ready-made parts simplify construction, but if it is desired to keep the cost down a little ingenuity will enable the builder to make good use of old stove parts, scrap material, and the like.

One all-important warning is in place here: The temptation to start a fire in a newly finished fireplace is tremendous, but must at all costs be resisted. The masonry should be allowed to dry for at least a week before it is subjected to heat, and only then further dried by means of a *slow* fire.

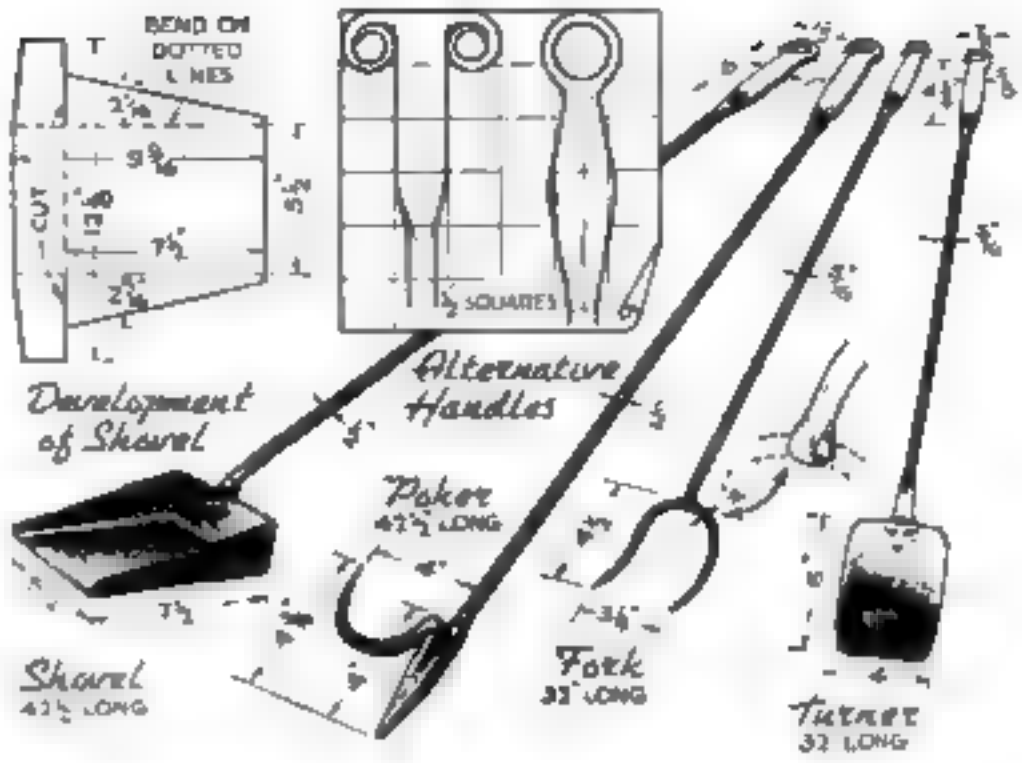


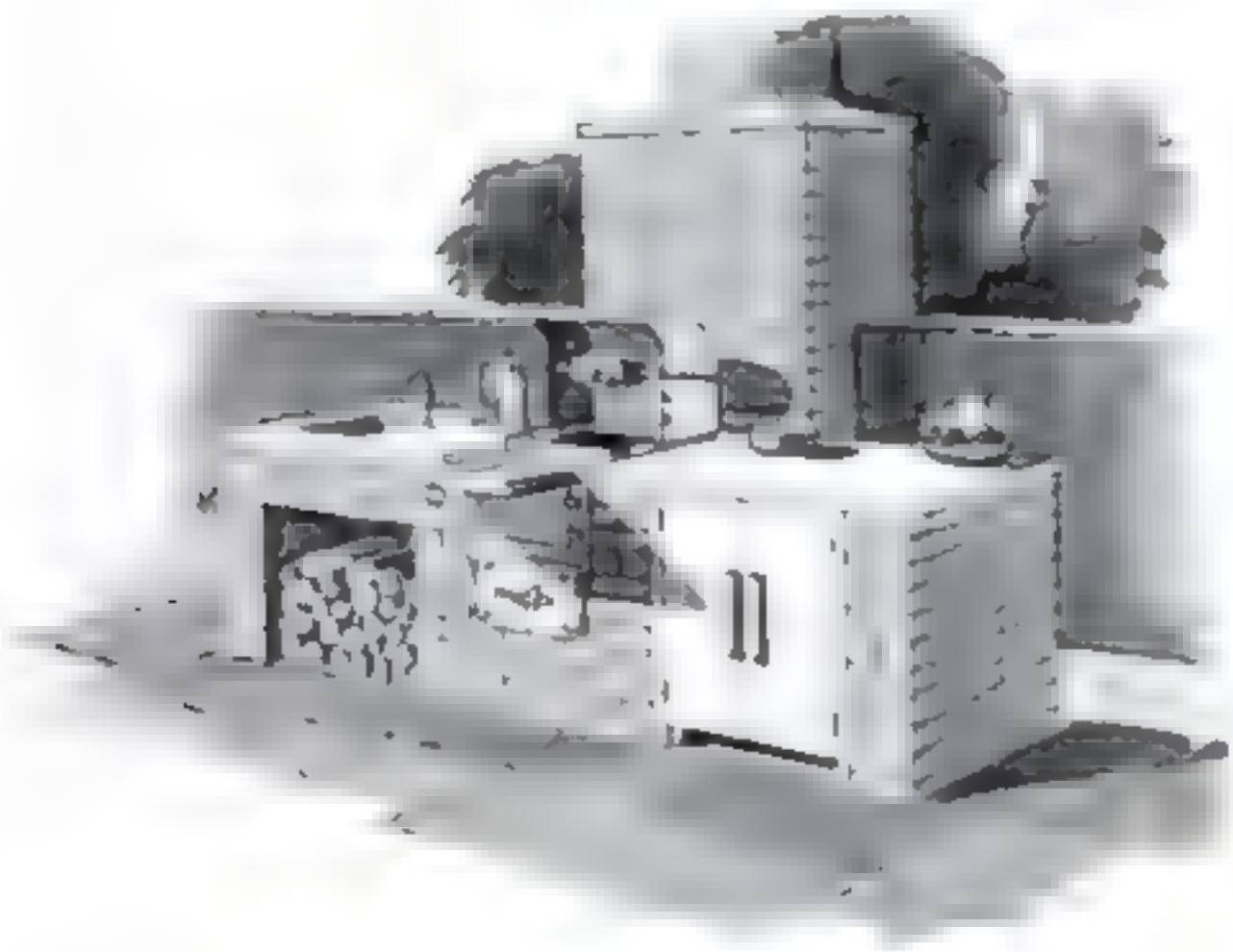
Fig. 7. These outdoor-cooking accessories can be made of sheet metal and iron rod. Rivet or weld the parts together

Having water available is especially desirable if the fireplace is at some distance from the house. A weatherproof electrical outlet also will be found convenient for connecting a radio, percolator, or lights.

Outdoor cooking requires special tools. Figure 7 shows a very useful set, which can be made directly from these drawings. It is a good idea to embed short lengths of iron rod in the masonry of the fireplace, as shown in Fig. 1, to hold such tools within convenient reach. A pair of asbestos gloves should also be available for handling hot utensils or other objects.

Hardwood and charcoal are the best fuels for cooking. It is important to remember that cooking is properly done over glowing wood coals, *not* over burning logs. It is for this reason that maple, oak, or hickory are preferred to softer woods, which burn to ashes much too quickly. It may take from one to four hours to produce coals for broiling, depending upon the depth of the fire required and the size of the logs used.

Fig. 6. Working drawings for this fireplace appear at the left. When broiling is to be done, the barbecue hood and spit shown are removed and the grill slid back. The entire fire-box assembly can be purchased as a ready-made unit

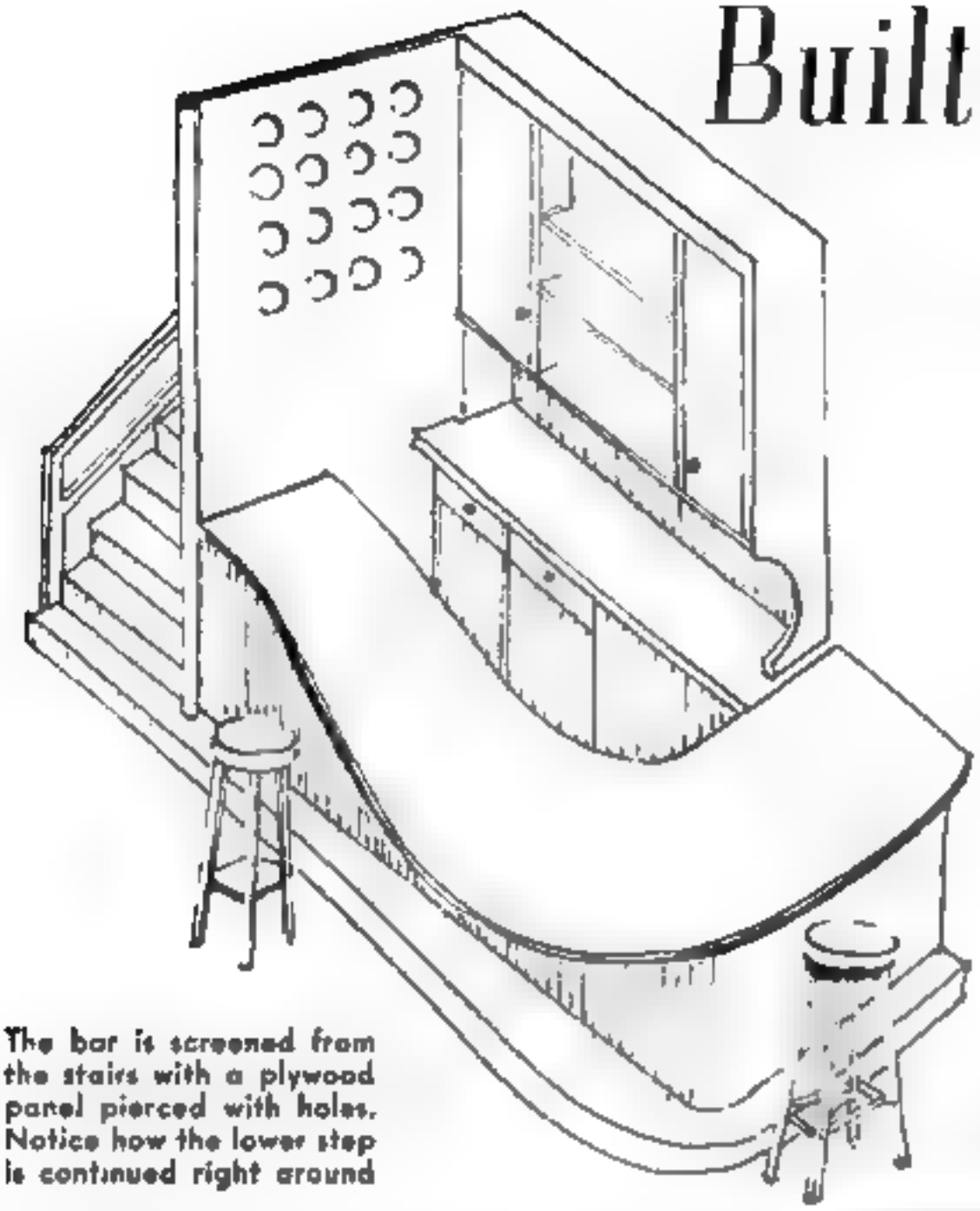


A good charcoal fire can be prepared in less time, and gives steaks a flavor that cannot be produced by other means, although it is claimed by some expert cooks that for broiling fish and chops oak coals are even better.

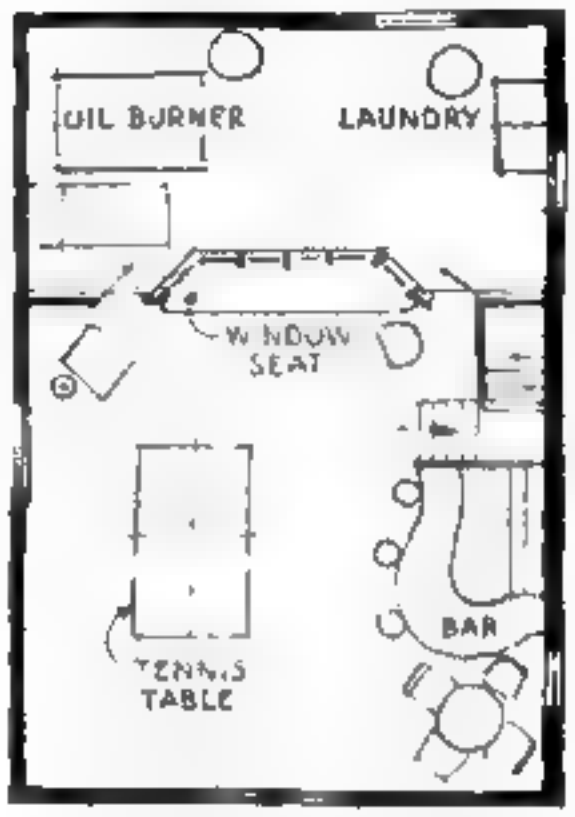
Flat plates are sometimes preferred to grills because meat can be cooked on them with less loss of the juices. Whichever is used, the meat should not be punctured with forks or knives during cooking any more than is absolutely necessary. Let it broil completely on one side, then turn with gloved fingers. It is a good idea to keep a pair of white cotton gloves especially for this purpose.

Built-in Bar for

DESIGNED AND



The bar is screened from the stairs with a plywood panel pierced with holes. Notice how the lower step is continued right around

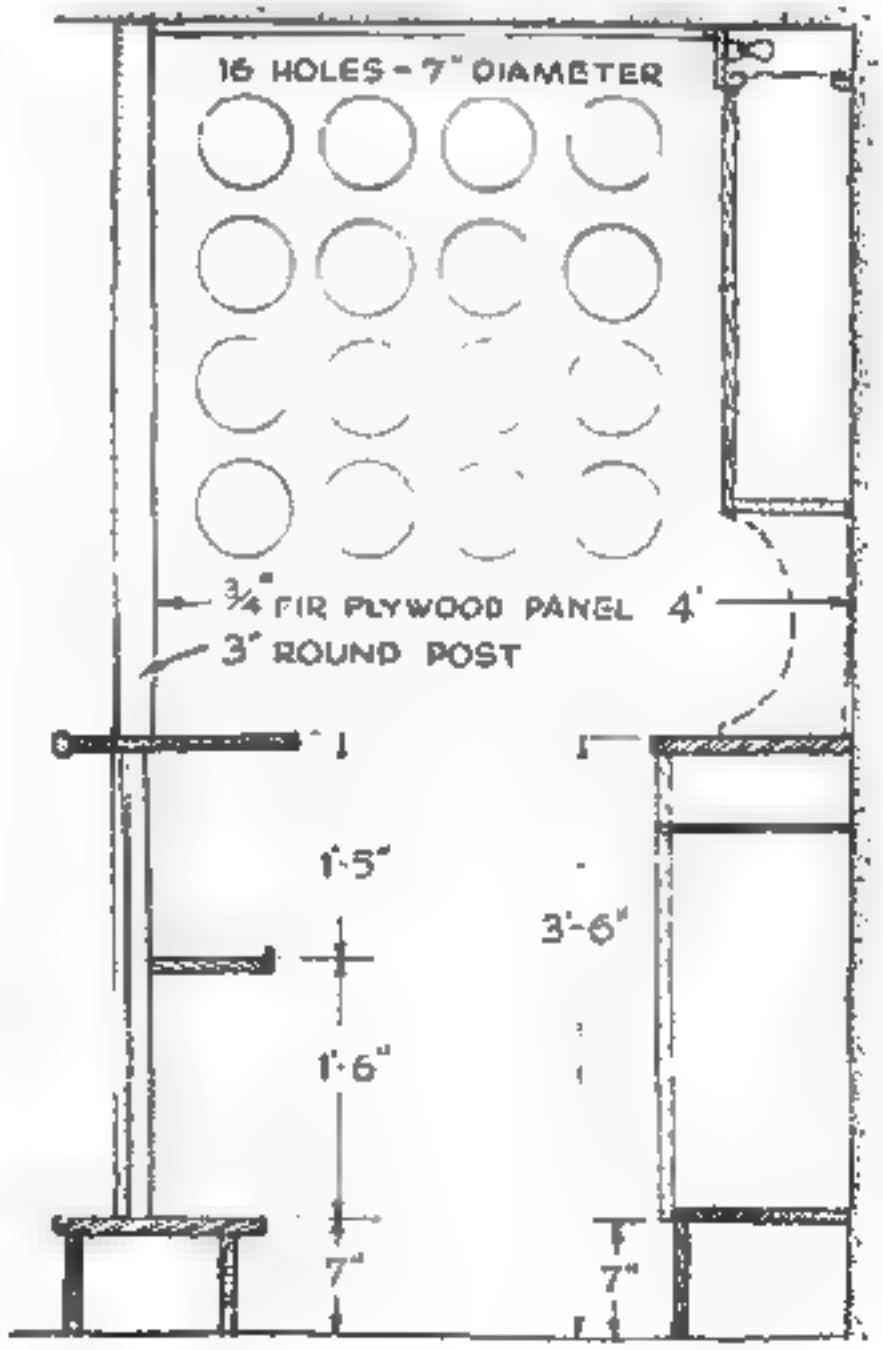


The basement plan and, below and at right, three views of the bar

HERE are the construction details of the built-in bar and cabinets for the basement recreation room illustrated last month (P. S. M., May '41, p. 162). This built-in section is separated from the stairs by means of a ¾" fir plywood panel 4' wide, braced with a heavy round post that rests on the top tread. The large panel has sixteen holes cut into it as a decoration: the inner edges of the holes, in this particular installation, were painted a bright red.

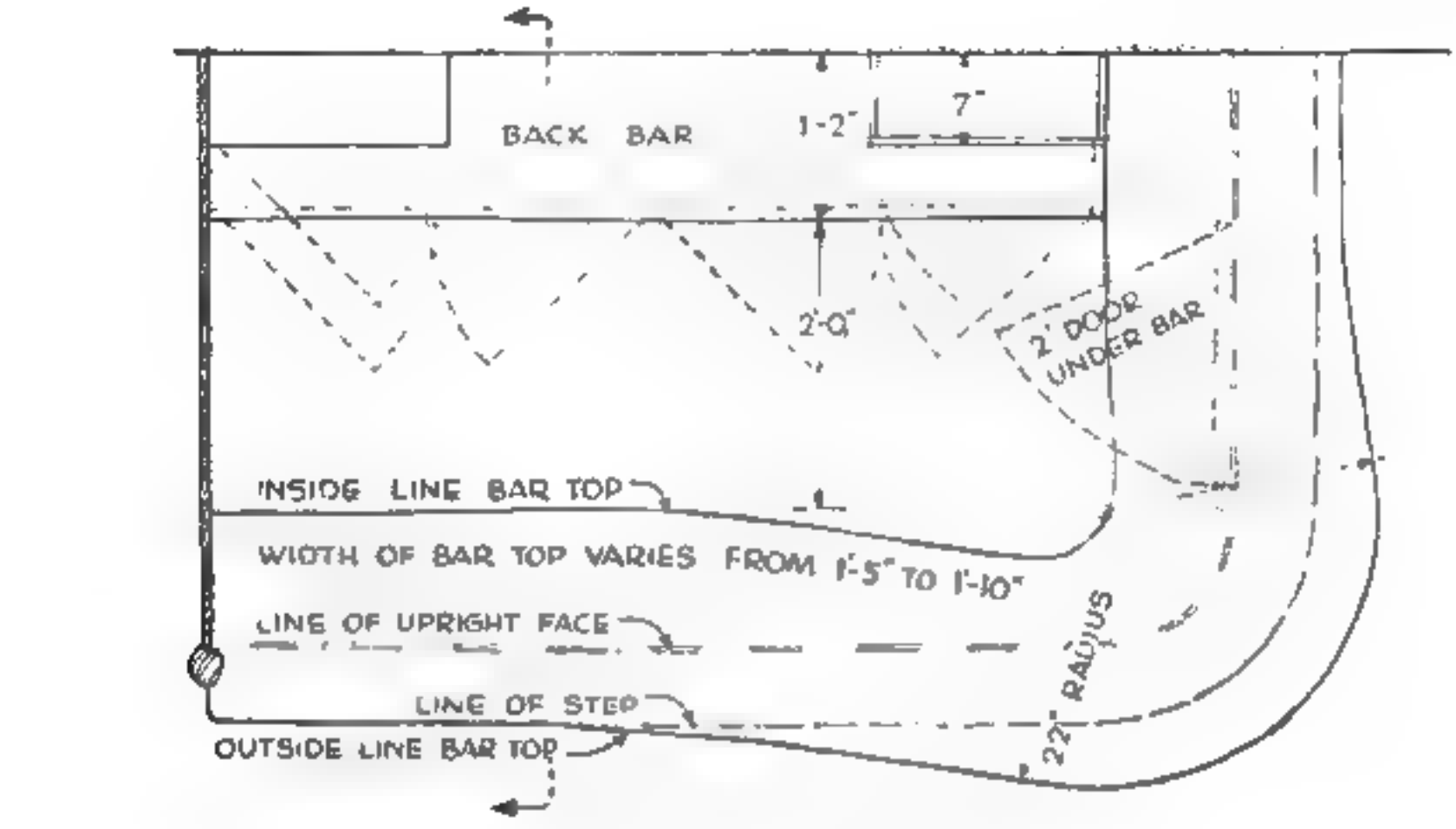
The bar top itself is of solid mahogany, but maple or other hardwood could be used. Access to the bar is through a hinged section in the upright part. The entire upright front of the bar is made of a ⅛" hard composition board bent around ribs. This may be finished in any way desired, but in the original room was faced with leatherette.

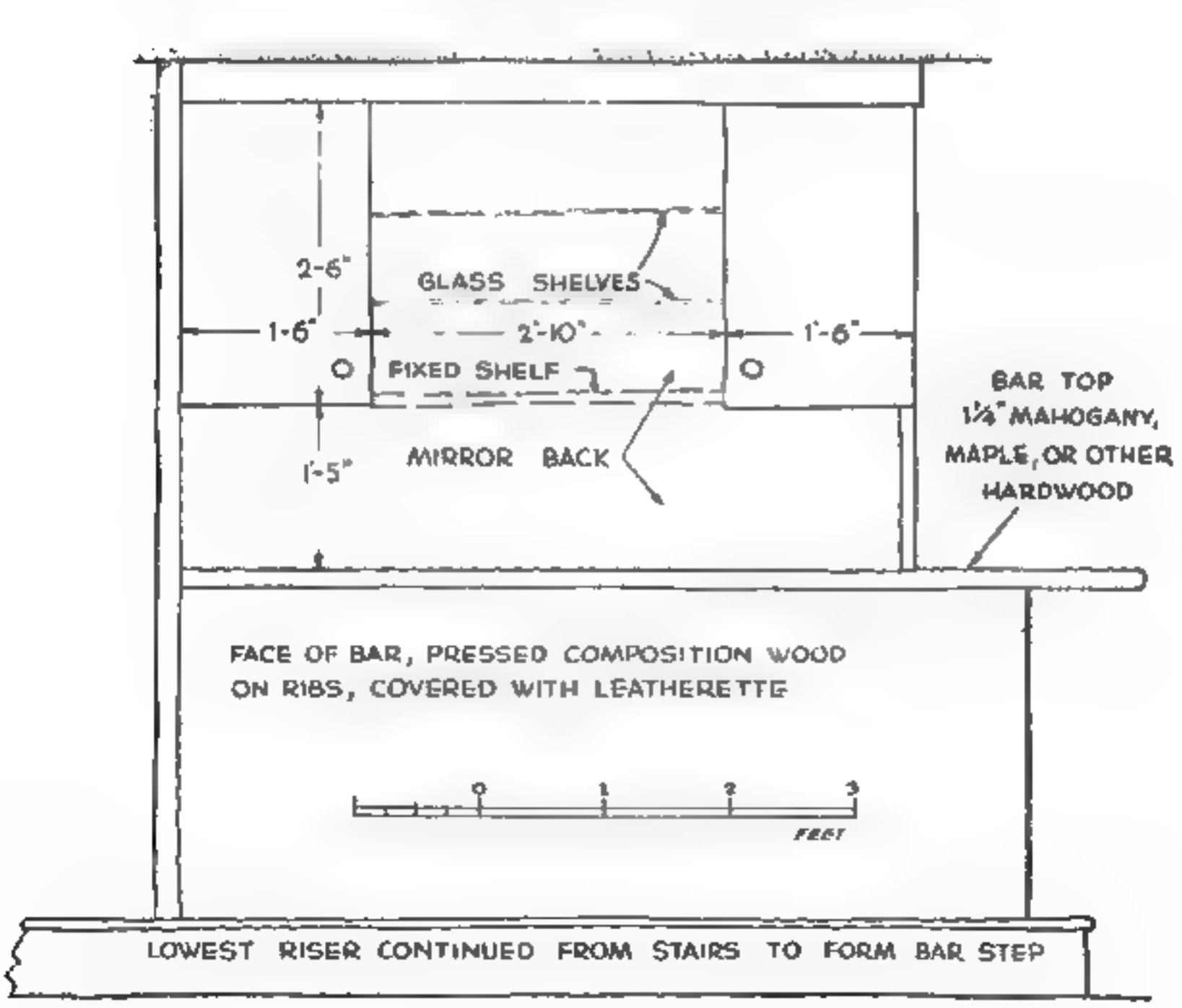
The back bar is a counter with a mahogany top and locked cupboards below. Above, two cabinets are fastened to the wall. The wall under and between them is hidden by mirrors. The joint between the mirrors is covered with a fixed shelf for glasses, while above it are two plate-glass shelves supported on pins in the sides of the cabinets. A fascia board covers the top, and so-called "lumiline" lamps are set into the space between the cabinets.



Basement Recreation Room

ILLUSTRATED BY JOSEPH ARONSON





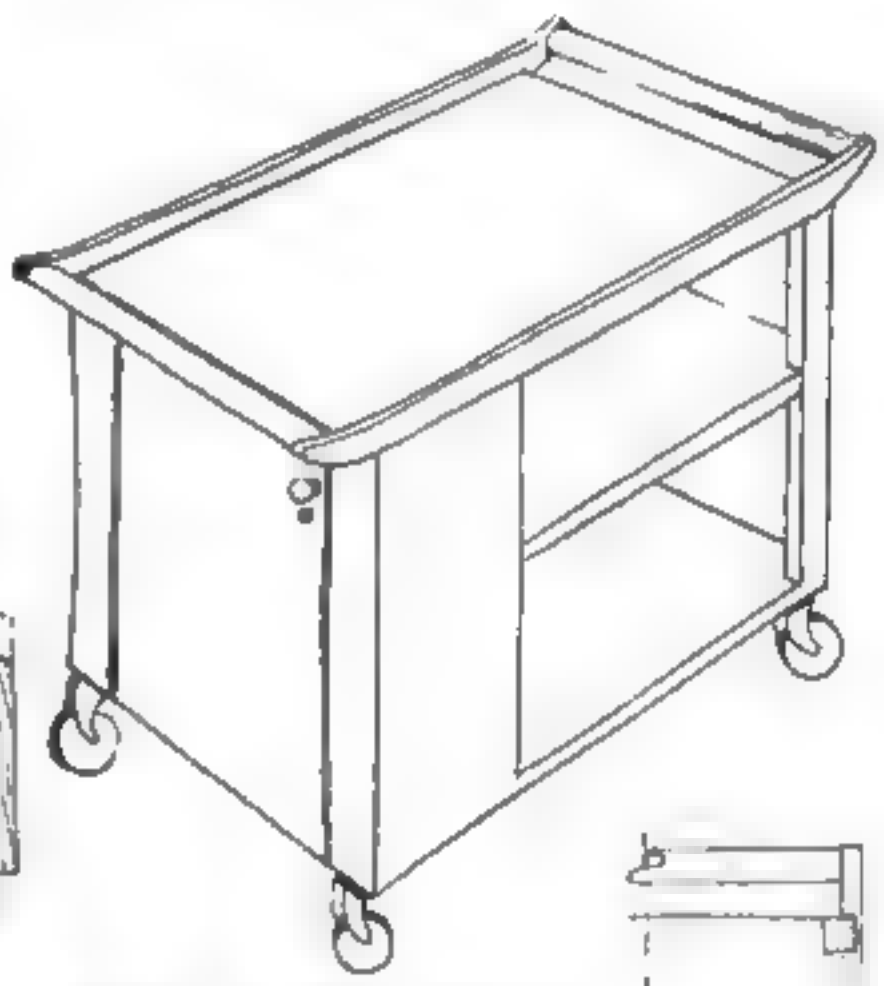
Refreshment Cart

By JOSEPH ARONSON
Author of The Encyclopedia of Furniture

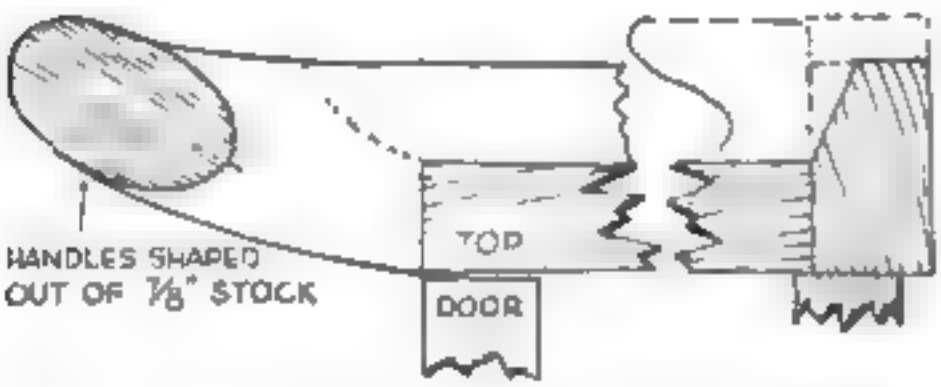
THIS refreshment cart is a modern version of the old, but always useful, tea wagon. It has an unusually large amount of tray surface in three tiers, as well as a closed compartment, which may be locked if desired. Materials: 13/16" plywood, 1 pc. 16¼" by 28" for top, 1 pc. 17⅛" by 20⅛" for middle shelf, 1 pc. 17⅛" by 27 3/16" for bottom, 2 pc. 6⅛" by 23⅛" for sides, 1 pc. 15⅞" by 22 11/16" for back, and 1 pc. 14⅜" by 23⅛" for door; 4 posts of solid wood, 1⅜" square by 23⅛"; 2 pc. ⅞" by 1⅛" by 34" for top side members; 2 pc. ⅞" by 1⅜" by 16¼" for handles; 4 good quality 3" rubber wheels or casters; 1 pr. 2" by 2" broad brass butts (hinges); 1 bullet or cupboard catch; 1 cabinet lock; 1 knob. Any available plywood and wood may be used.

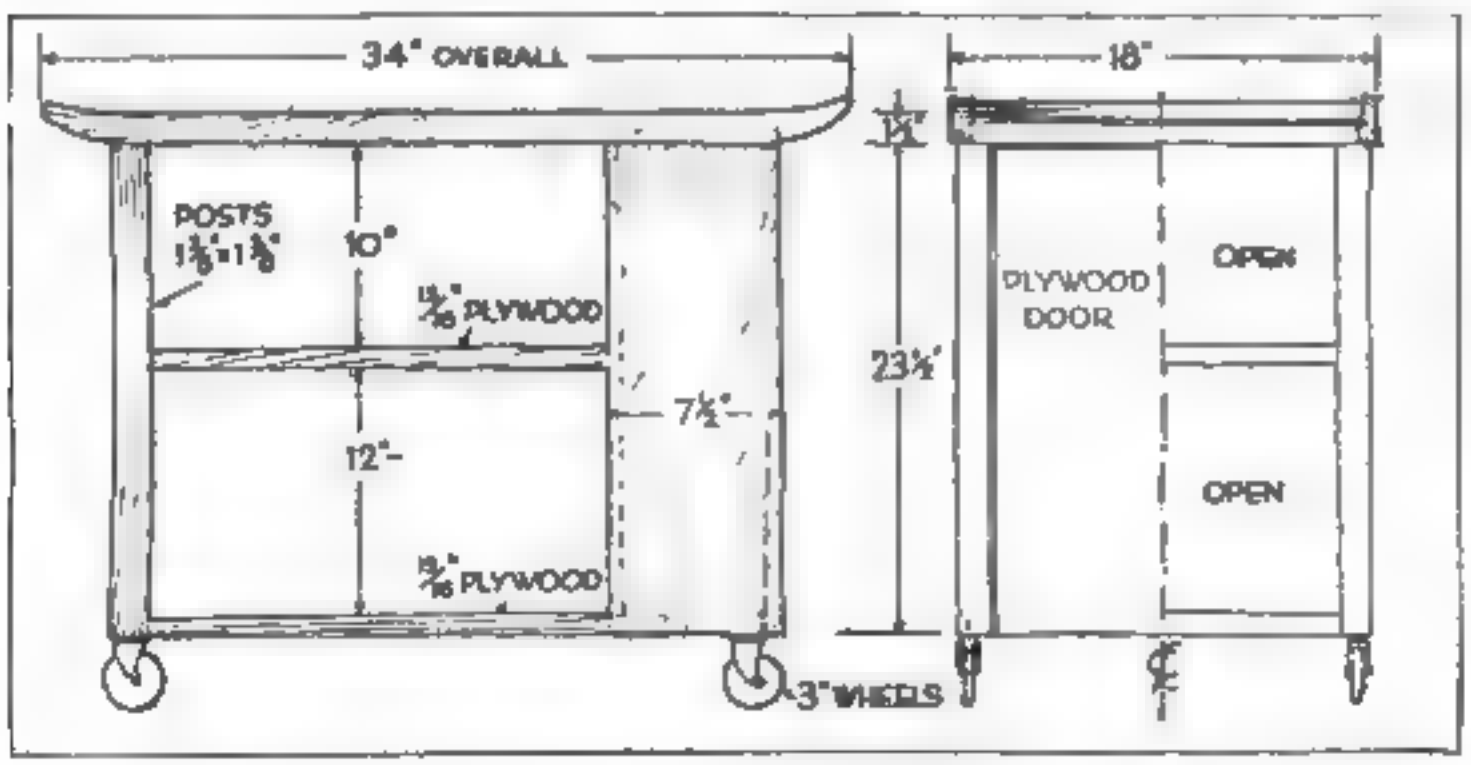
Build up the cupboard section by doweling the sides and back together, and dowel this to the bottom. Dowel-joint the other members. Note that the top panel is framed with two strips ⅞" by 1⅛", and the end members of this frame are shaped bars, which serve as handles. Assemble the top like a tray and dowel it to the case and posts.

Colored lacquer or enamel is recommended for the finish, as such a piece is likely to be used in several rooms. A soft gray will be quietly harmonious with mahogany, walnut, or maple furniture, although many other shades might be suggested by the room furnishings. Whatever the finish used, a good quality wax applied over the final coat and rubbed down will be found to provide a considerable degree of protection against hot dishes, liquids, and alcohol.



These are Mr. Aronson's own sketches of the cart, which is most easily made of plywood, if available





Loosely fitted insulation board between the wall proper and false studs such as these will reduce noise leakage. Mineral or glass wool padding may be used instead

NOISE CONTROL *in the* HOME WORKSHOP

By EDWIN M. LOVE

THE whine of the circular saw and the buzz of the jointer are music in the ears of the confirmed home-shop enthusiast, but not so to his family in the living room, or neighbors beyond the fence. To them these machines are merely vexing noise makers, suffered in patience or railed against, according to the temperament of the individual. Whether located in the basement or the garage, the home shop is a potential disturber of the peace, and it is up to the owner to keep its racket within limits.

There are two points of attack—reduction of sound at its source and restriction of its passage through the walls of the workroom. There is little hope of eliminating the noise of a machine in action. A circular saw takes 150 or more bites a second, and the wood being cut vibrates from these impacts like a sounding board. But criticism can often be avoided by proper timing. Plan the work on a project so that loud machines are used in the early part of the evening, leaving quiet processes for later hours. Careful thought in this respect may save the trouble and expense of soundproofing.

In many cases, however, tact alone is not enough. If light manufacturing is attempted, it is especially important that noise leakage be limited.

Sound is transmitted mainly in two ways—by direct vibration and by air waves. An unbalanced machine, bolted solidly to the floor or wall, may set up vibrations that travel through the whole frame of the house. Air-borne sound waves, surging against thin walls and ceilings, set these members to vibrating like a drumhead, and they reproduce the sound outside.

The average home-workshop machine is remarkably well balanced, yet even a slight vibration, if transmitted to the floor and walls, may set up an astonishing amount of noise. The remedy is a matter of adapting to shop mechanism the familiar rubber mounting of an automobile engine. Try putting a block of sponge rubber under each foot of the machine, and tighten the bolts only enough to hold the base in place, as sketched. In a similar way machine stands may be sound-insulated by setting their casters into a slotted block cushioned in a wooden cup on a square of sponge rubber. If the machine tends to rock in service, substitute a more solid type of rubber.

Tool boards or cabinets attached to machine stands can be quieted by covering the supporting bolts with rubber tubing and using rubber washers under boltheads and nuts. Sheet-metal housings sometimes vibrate with unpleasant sound effects, but can be damped by lining with ½" fiber insulating board, or a special asbestos sheet that may be cemented in or held with screws and sheet-metal washers. The same treatment

is effective for silencing ventilating ducts.

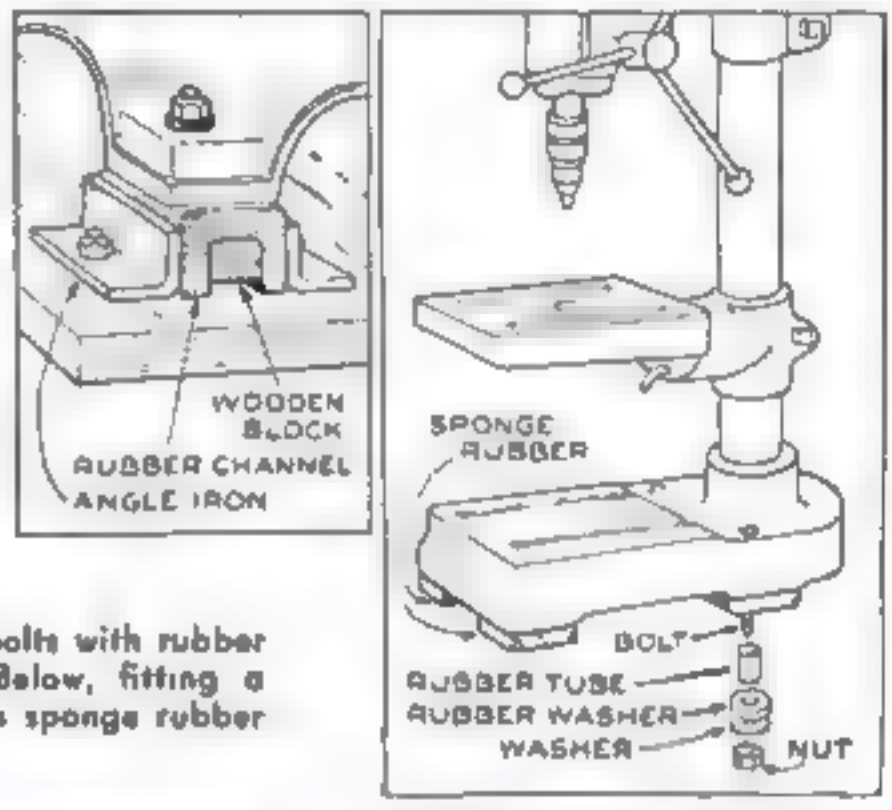
Noise that cannot be prevented should be confined to the workshop. If the shop is in the basement, sound penetration through the walls is no problem. But the ceiling is another matter. In one of the drawings is shown a method of reducing sound leakage by building a false ceiling under the floor joists. It is hung without direct connection to the floor on 2" by 3" subjoists laid across the foundation walls. Whereas insulation board nailed to the floor joists proper would defeat the purpose by transmitting vibration to them, insulation board fastened to such hanging subjoists, being free to vibrate independently, damps out much of the sound. If the cellar is too large to span with subjoists supported only at the ends, support them between the walls by means of insulated hangers. These are made of 1" by 3" stock and ½" insulation board in such a manner that there is no wood-to-wood contact between them and the ceiling joists proper.

Still greater insulation efficiency may be obtained by the use of a mineral-wool blanket tucked between floor and ceiling joists, in addition to the insulation board.

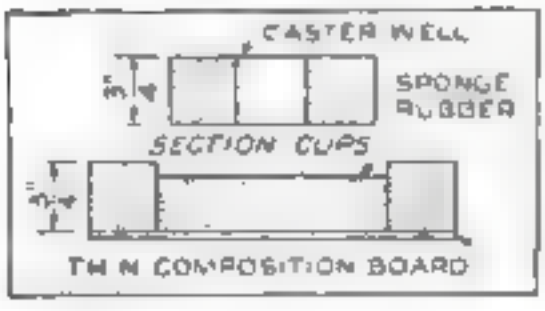
Ceiling light outlets can be extended by bringing wires down from them to boxes and fittings installed in the hanging ceiling.

An attic workshop reverses the situation and requires a floating floor. As strength is necessary, 1" by 3" sleepers are laid over insulation board tacked to the floor, spaced about 16" from center to center, and a finish floor is nailed to these. Attics often have studded walls through which sound passes with ease, this being especially true of walls that are unplastered or lined only with thin wall board. Filling the spaces between the studs with mineral or glass wool will reduce sound leakage as much as 40 percent.

More complete insulation requires a false wall built on 2" by 2" studs inside the partition separating the room from the rest of the house, or even a floating wall all around the room similar to a floating ceiling. The



Insulating machine bases and mounting bolts with rubber will reduce much noise at its source. Below, fitting a lathe stand with caster cups cushioned on sponge rubber



Simple rubber-mounted caster cups keep machine stands from creeping, and absorb vibration

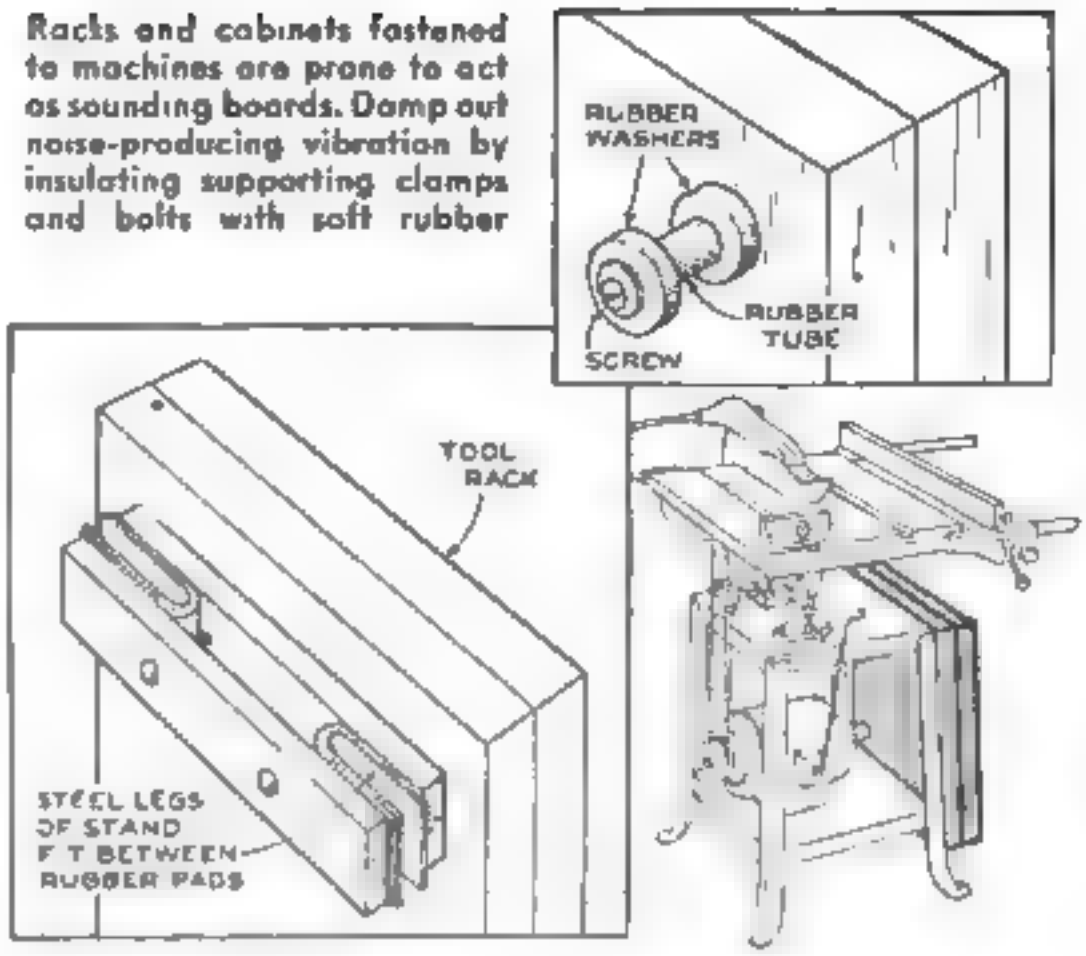
plates (horizontal members) are separated from floor and ceiling with strips of ½" soft-fiber insulation board, through which they are spiked. Leave ½" between plates and the wall. If the floor is concrete, insert insulation pieces in the space between plates and wall, in addition to the other padding, and nail the plates to the wall. Studs are spaced 16" on centers to come between the old wall studs. Keep plate ends and end studs separated a little from end walls.

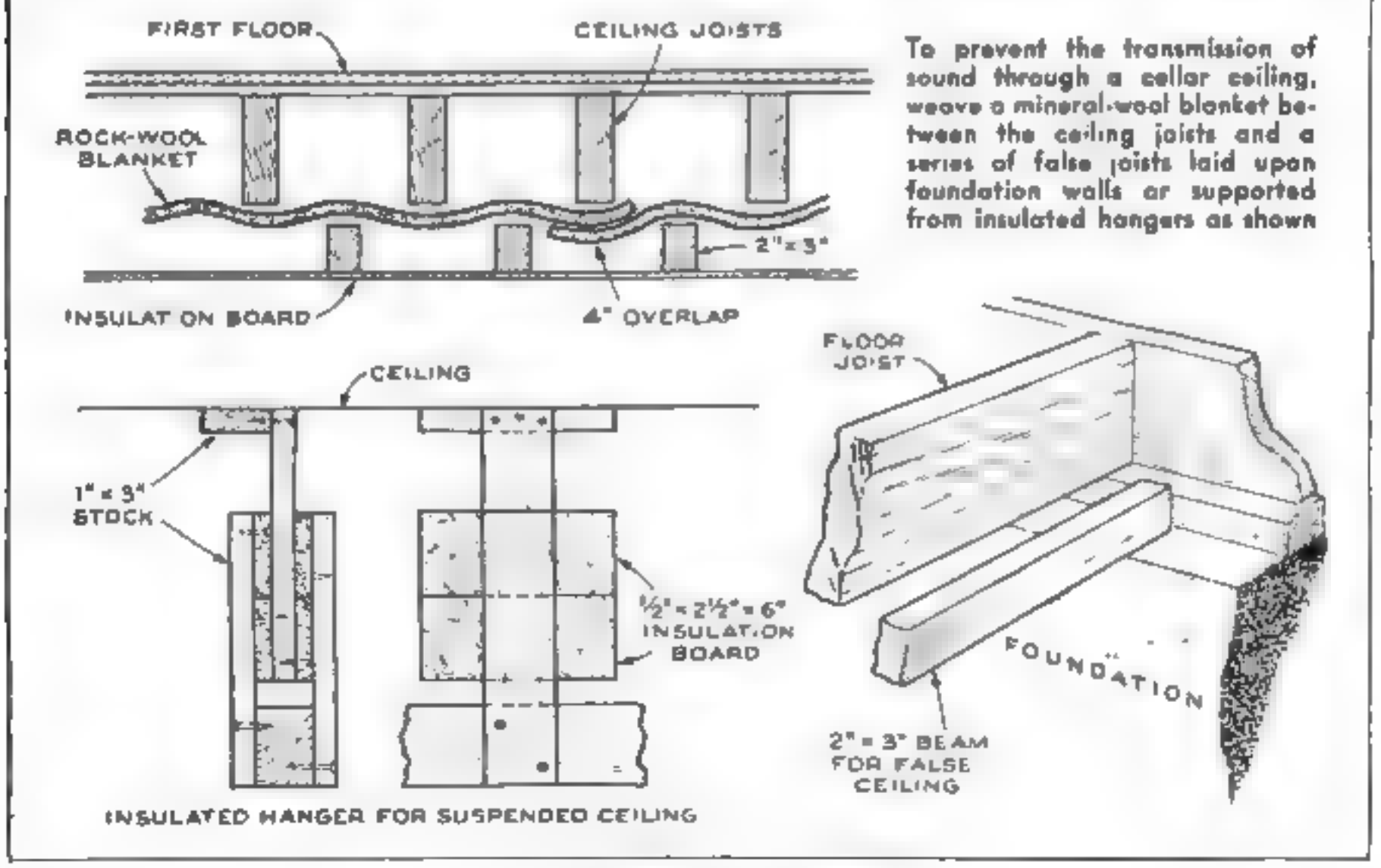
A single blanket of insulation padding inserted between the two sets of studs should result in a reduction of as much as 50 percent in noise transmission; a double blanket, 75 percent. The false wall is then preferably covered with ½" insulation lath and plastered. If insulation board is used between the two sets of studs instead of padding, apply it as described in the following paragraph.

Where a false partition is added to a ceiled or plastered partition, use 2" by 4" plates nailed as previously suggested, with 2" by 2" studs spaced 16" on centers. Stand sheets of ½" insulation board between the floating studs and wall, as in one of the photos, overlapping the sheets 4". They are left unnailed. Lath and plaster complete the wall.

What of openings? An ordinary window will let through as much noise as walls, floor, and ceiling combined, and the inference is that if noise is to be confined, windows must be dispensed with in favor of artificial light and ventilation. If windows are to be retained, equip them with weather strips, set the glass in rubber or leather channels held with wooden strips, and install storm sash, leaving as much air space as possible between inner and outer panes. Glasses of different weights help damp out sound. Glass bricks, if properly cemented, will serve

Racks and cabinets fastened to machines are prone to act as sounding boards. Damp out noise-producing vibration by insulating supporting clamps and bolts with soft rubber





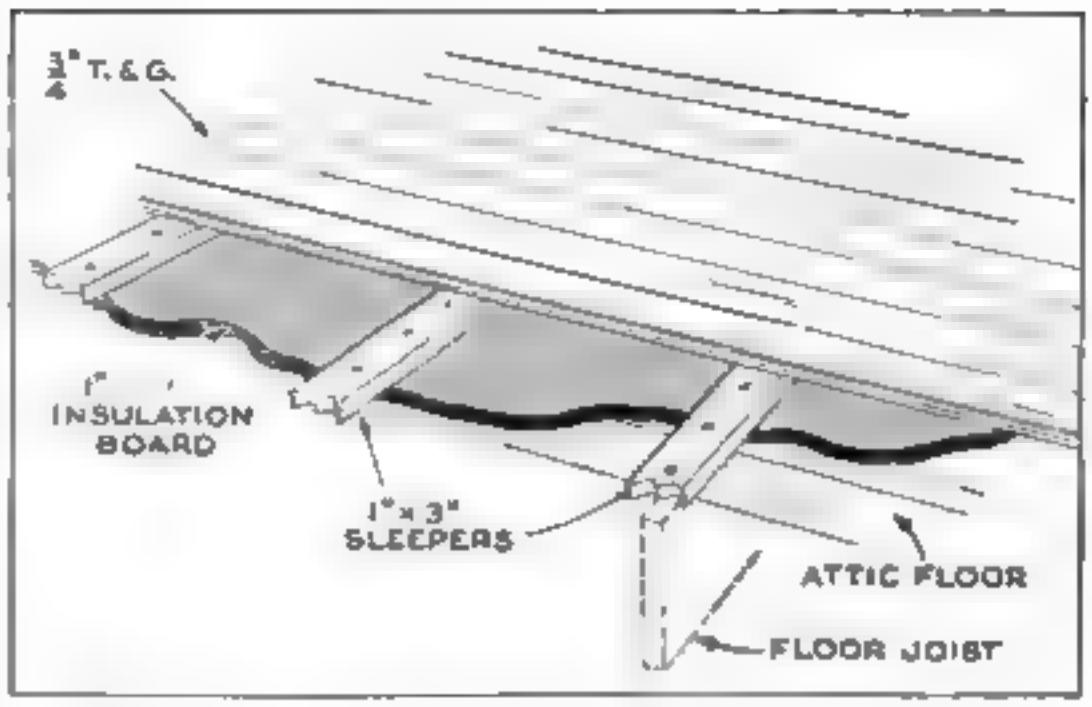
To prevent the transmission of sound through a cellar ceiling, weave a mineral-wool blanket between the ceiling joists and a series of false joists laid upon foundation walls or supported from insulated hangers as shown

as fairly good sound insulators.

Weather-strip all doors, and cover one or both sides with ¾" tongue-and-groove boards. The extra weight, as well as the thickness, goes far to deaden sound transmission. It will be necessary to set over the hinges and perhaps the stops, and a third hinge may be needed to support the weight. If sound persists in penetrating an entrance, a vestibule with a second door may be added.

Finally, fill all holes, even the openings through which pipes enter or leave the shop. If there is enough clearance in the hole around the soil pipe, make a sleeve of insulation board and push it up into the hole, or use a piece of wool batt. Rock wool or similar material can be loosely tamped in if a sleeve is not practical, and is also good for plugging oddly shaped openings.

This completes our discussion of equipping, lighting, and soundproofing the home shop. The next article in this series will contain some suggestions for those who wish to earn money by their craftwork.

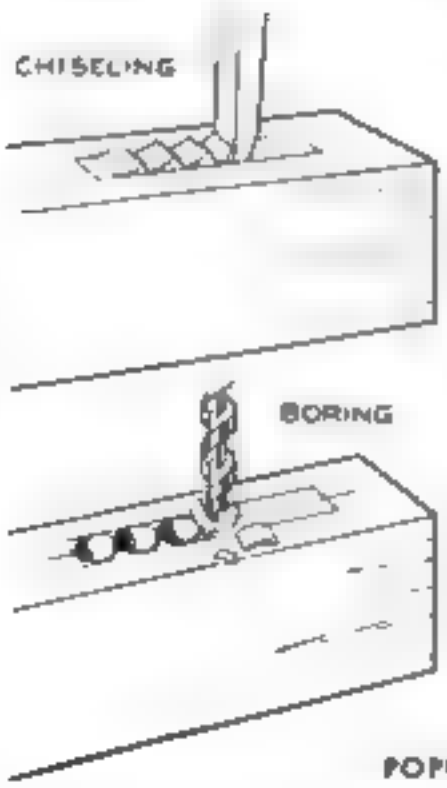


A floating floor will absorb much of the noise of an attic workshop. The sleepers must be laid over insulation board

Sanding Disk Serves as Nonskid Worktable for Small Parts

TO HOLD small or delicate work for sanding or other operations—work that because of its shape or fragility cannot be gripped in a vise—a motor sanding disk may be used. Clamp it face up in a vise and lay the work upon it. Sand with a finer grit than that on the disk, using a block, as shown. A friction surface made by gluing coarse sandpaper to a piece of plywood may be used in a similar manner as a nonskid worktable.—F H.

MAKING A MORTISE BY HAND [WOODWORKING]



1. *With Mortising Chisel.* (a) Mark length of mortise, and gauge its width from face side or edge, this width being equal to the thickness of the tenon the mortise is to receive. (b) The chisel used should be of the same width as the mortise to be made. Make cross cuts with chisel and mallet, starting near one end and spacing the cuts about ¼" apart. Pry the chisel backward and forward to break the chips, and rake them out. (c) Work from end to end until the bottom is even. The depth should be a little greater than the length of the tenon, to allow space for excess glue. (d) Trim the ends to the line.

2. *With Auger Bit and Chisel.* (a) Lay out as above, and draw a center line. (b) With an auger bit bore a line of overlapping holes to mortise depth. (c) Trim sides and ends with a chisel.

Through mortises should be cut from opposite edges to avoid splintering.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

For exploring rivers and inlets—and when the wind dies down—an outboard motor is a useful auxiliary

Cruising Sailboat

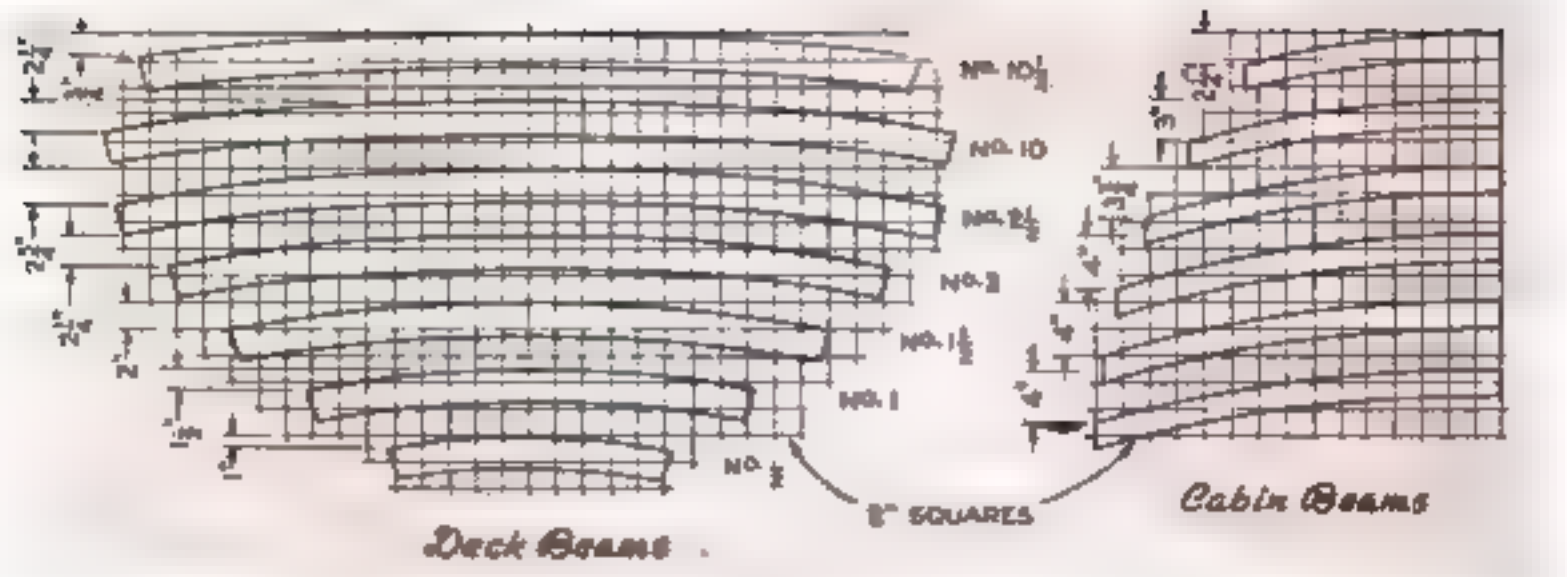
PART IV: HULL OF "WHITECAP" NEARS COMPLETION WITH ADDITION OF DECK AND CABIN

By Bruce and Willard Crandall

NOW that the hull of our 19' cruising sloop *Whitecap* has been planked, it will hold its shape and may be removed from the form and turned right side up. Before going further, it will be wise to give the inside one or more priming coats of paint.

The sheer line should be planed until it is perfectly fair, and then the breasthook, deck beams, and carlings may be installed. Several cross braces will be necessary to hold the hull in shape until the deck and cabin are in place. The curves of the deck beams may be laid out from the drawings. As the center line of the deck is perfectly straight fore and aft, a cord or wire may be stretched from the stem to the center of the transom to aid in lining up the deck beams. The deck beams are screwed to the side frames, and in the case of the intermediate beams to cleats fastened to the battens. The curves of all the short deck beams can be taken from the curve of No. 10.

Great care should be taken in fairing up the deck beams. The length of the short deck beams must also be such that the carlings and the coaming assume a true curve. A ¾" by 1¾" piece notched into the breasthook and beams will act as a center deck

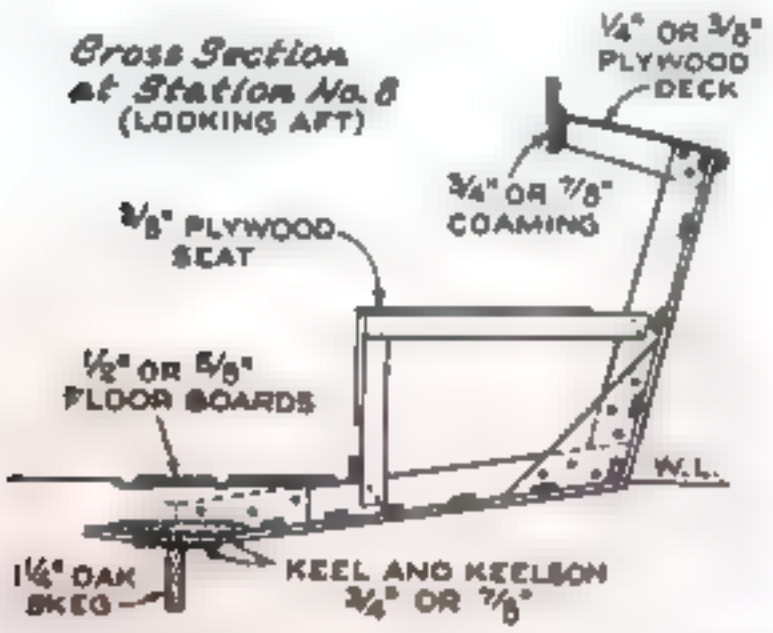


Patterns for the beams. Adjust the length of the cabin beams to suit the individual boat

batten. This also must be properly faired.

The deck may be either nailed or screwed. Doubling up the short deck beams will be necessary where joints occur in the plywood. If the deck is not to be canvas covered, be sure that these joints are made water-tight with plenty of marine glue.

The coaming is screwed to the carlings and cut to shape as shown in the drawings.

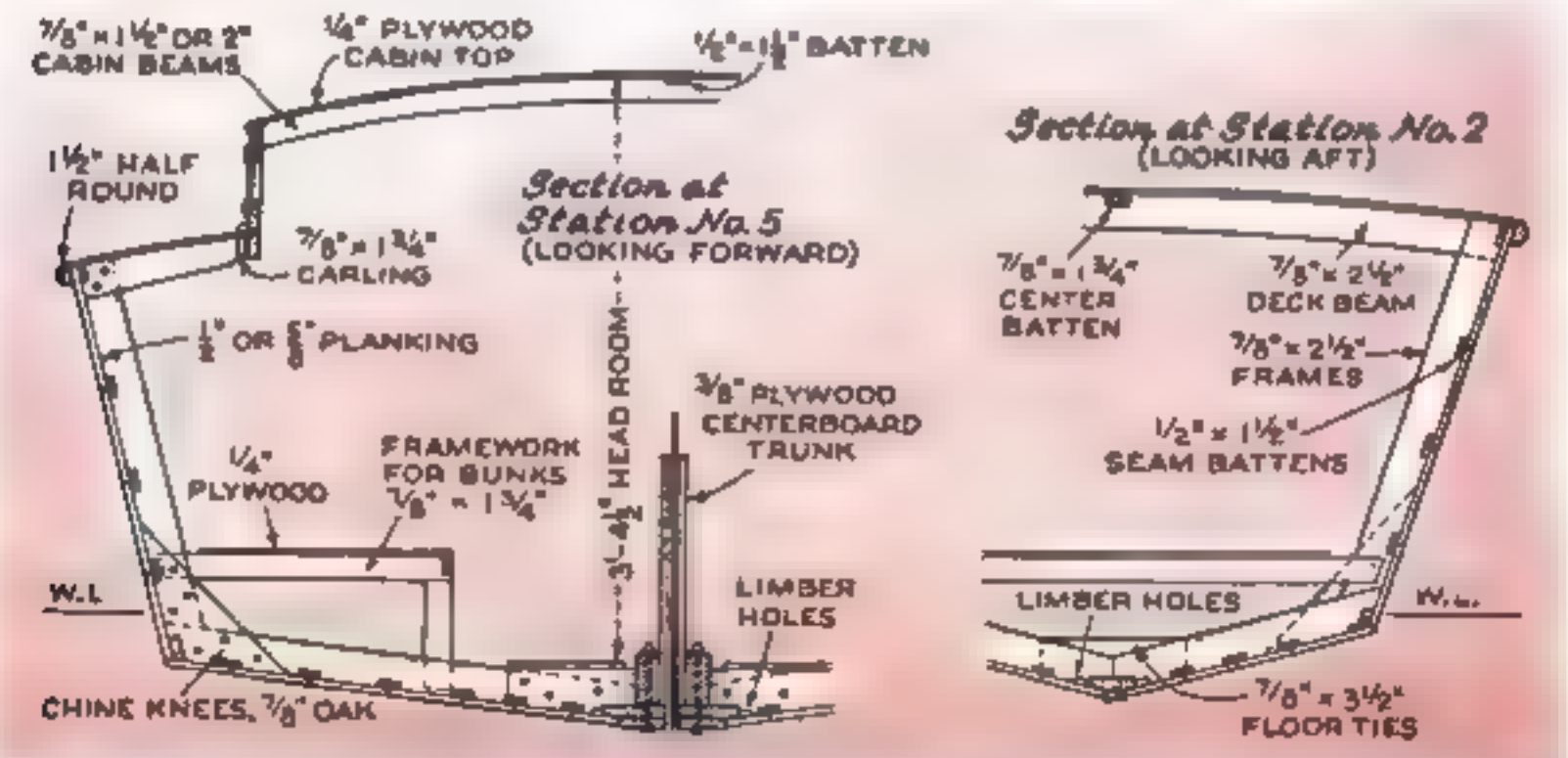


The approximate curve of the cabin beams is given in the drawings, but their lengths will vary slightly with the individual boat. They are fastened with screws to the coaming

A ¾" wide slot is cut through the keel and keelson for the centerboard well. The centerboard trunk is built as shown. Its plywood sides are first screwed to 1¾" by 8½" bed logs. Use marine glue on the joining surfaces. Next, what will be the inside of the trunk is painted, and the sides are fastened to the end posts with 1¼" No. 8 screws, spaced about 1½" apart, plenty of marine glue again being used on the joining surfaces.

The bottom of the trunk assembly must be perfectly shaped to fit the keelson, and a canvas gasket cut out, which, when soaked with marine glue, will make the joint between bed logs and keelson water-tight. The bed logs are then bolted through the keelson with galvanized carriage bolts, at least six

Three cross sections of the hull at stations Nos. 2, 5, and 8. These show the seam-batten construction used in building the original model

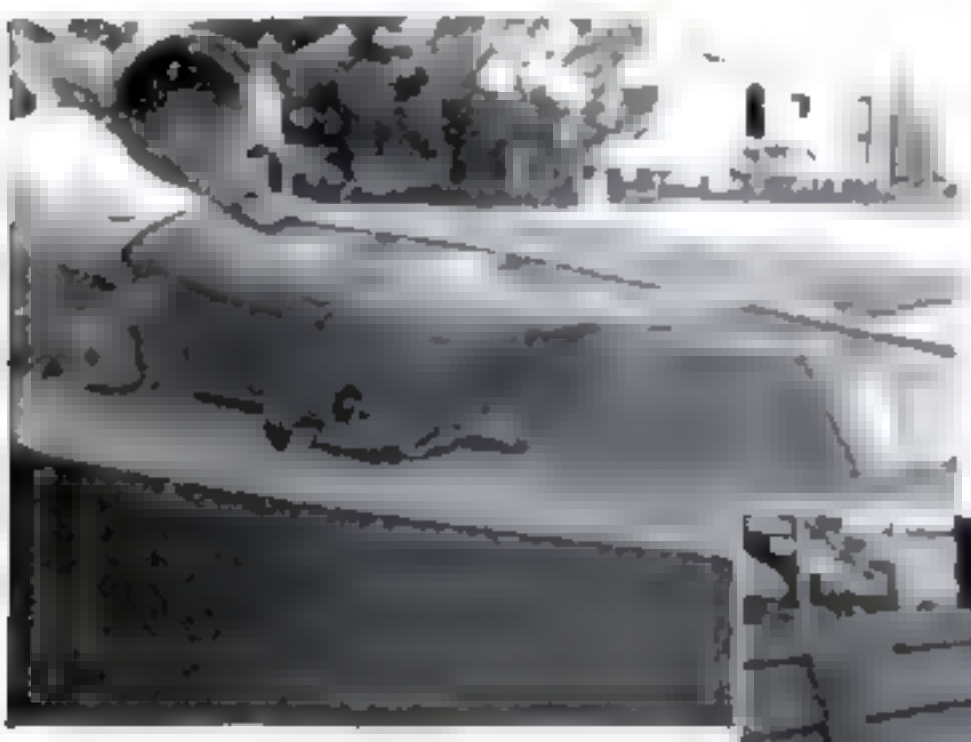


The edges of the plywood deck are planed flush with planking and carlings, then sealed with resin sealer

to each side, and the protruding ends of the end posts are sawed off flush from the outside of the boat. The whole assembly is later braced to the bunks and cabin roof.

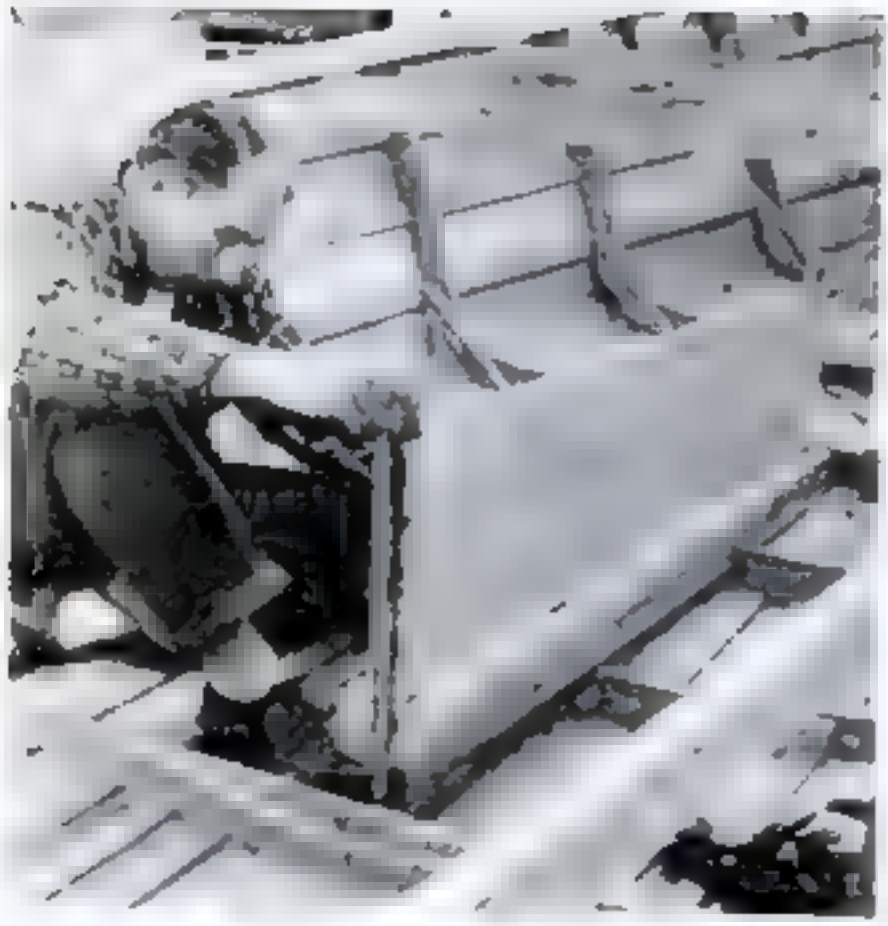
The rudder is made as in the drawings, with ¼" galvanized rods driven through at various places to prevent warping. It will be attached to the sternpost with standard gudgeons and a ⅝" rod.

The mast step and partner should be cut out and installed as shown, and fastened to the frames and cabin beams. For strength and light weight, the partly hollow mast preferably should be of Sitka spruce. It should be solid as far up as the boom fitting, at the top, and at the point where the tangs are fastened. Assemble the mast with resin glue or casein and hold it

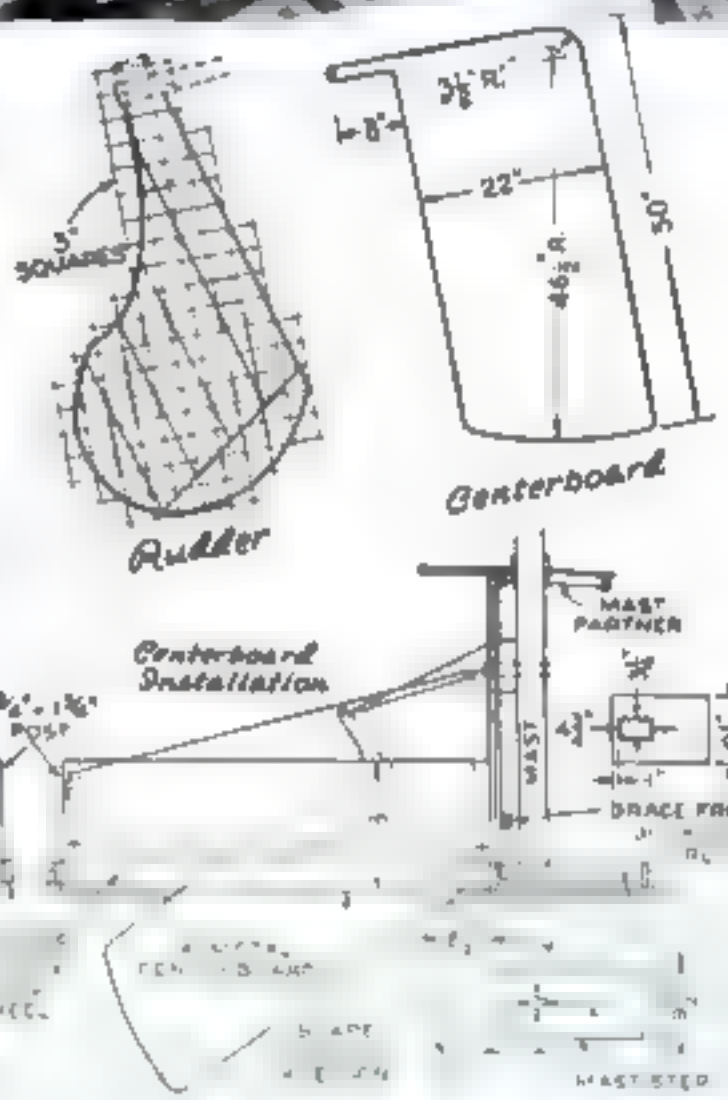


The importance of fairing the deck and cabin beams properly cannot be overemphasized. It is a task requiring great care because any slight unevenness will be conspicuous after the deck is added

The curve of the short deck beams can be taken from beam No. 10. To give additional support to the carlings and deck beams, it is necessary to brace them securely with diagonal supports at two or more points on each side

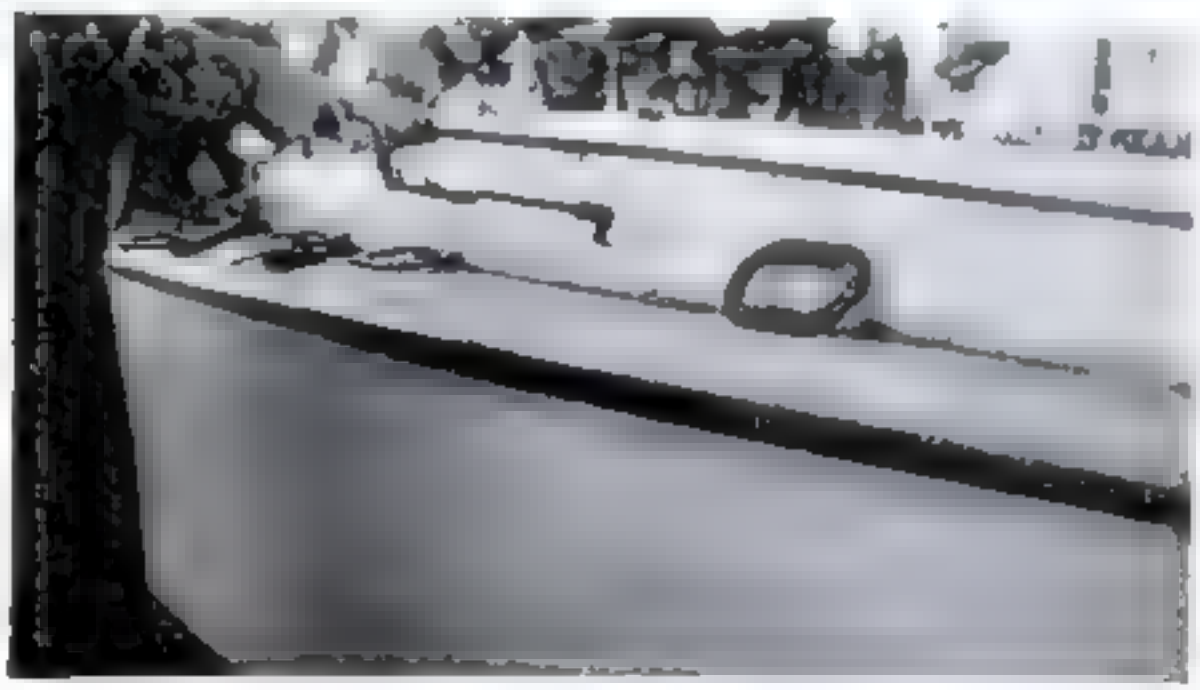


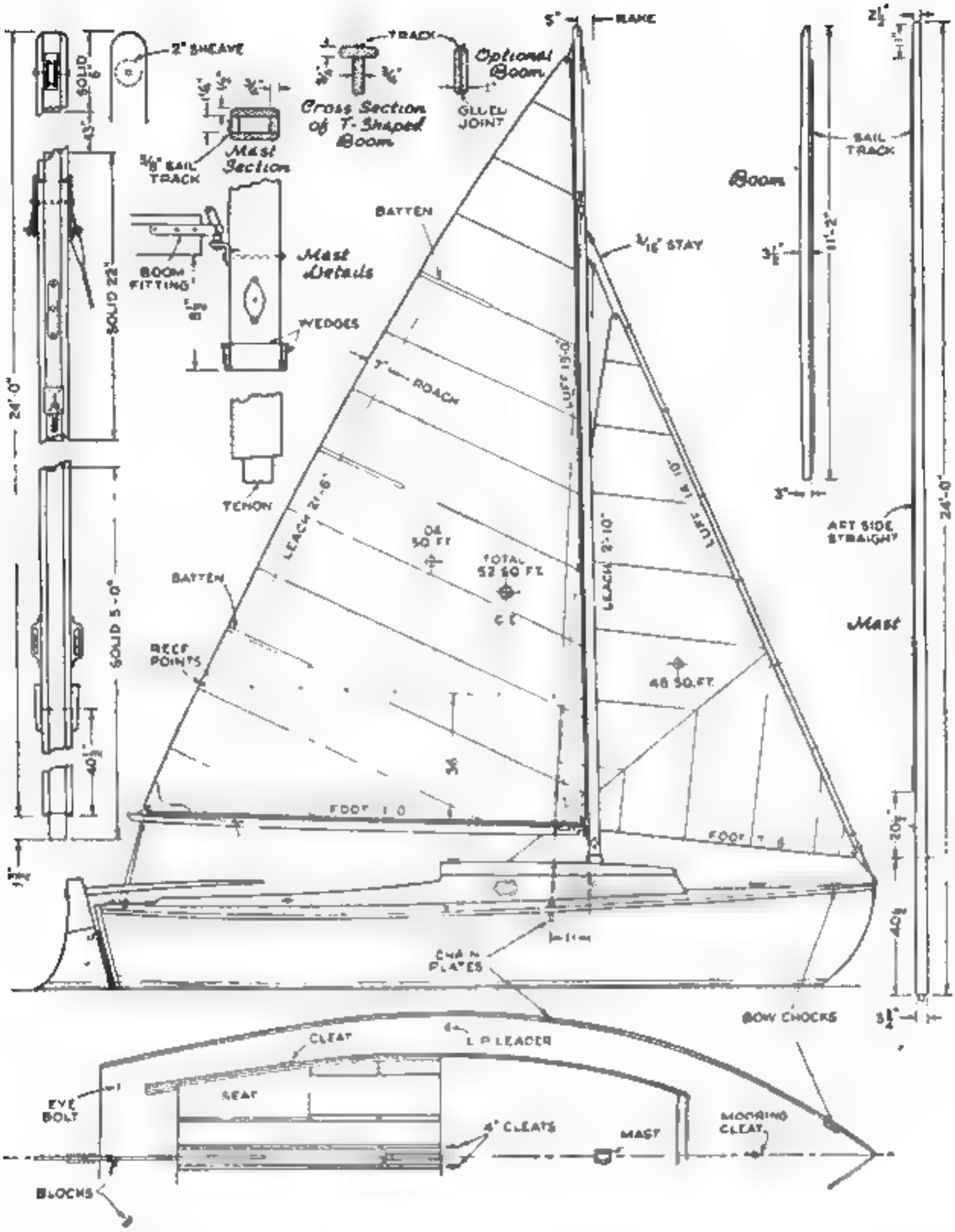
The assembled centerboard trunk must be fitted accurately to the keelson, to which it is bolted. Above at right, after the rudder is cut to shape, the aft and bottom edges are slightly streamlined



The mast step and corresponding mast partner should be installed before the top of the cabin is completed. Their dimensions are given in drawings at right above

Right, holes are bored so that the portholes can be sawed out. Notches or rabbets are then cut to hold the glass, which is retained with plywood frames



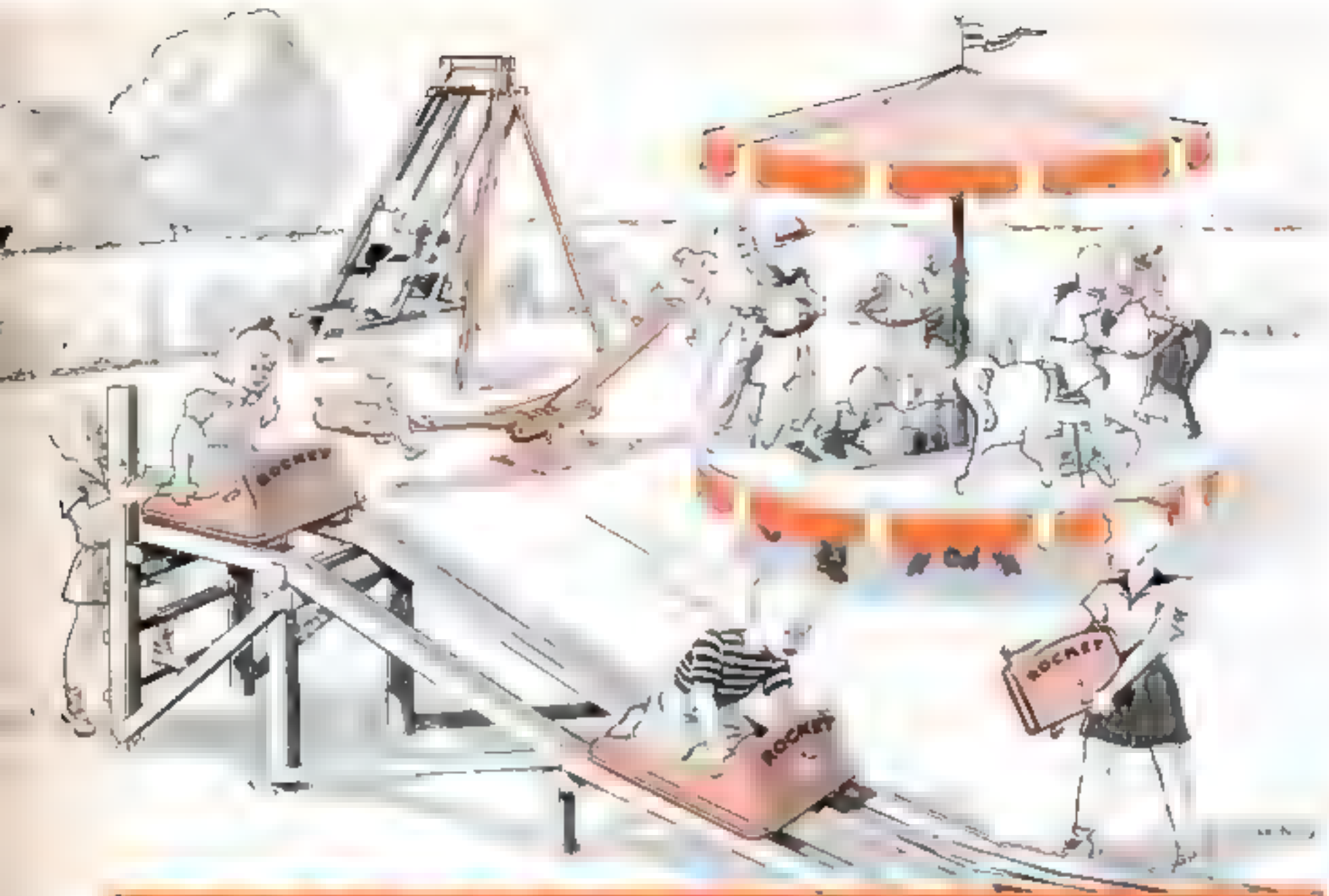


Sail plan and details of mast and boom. It is advisable to have the sails made by a professional. The boat can carry more canvas than this, so an alternative sail plan will be given in the next issue

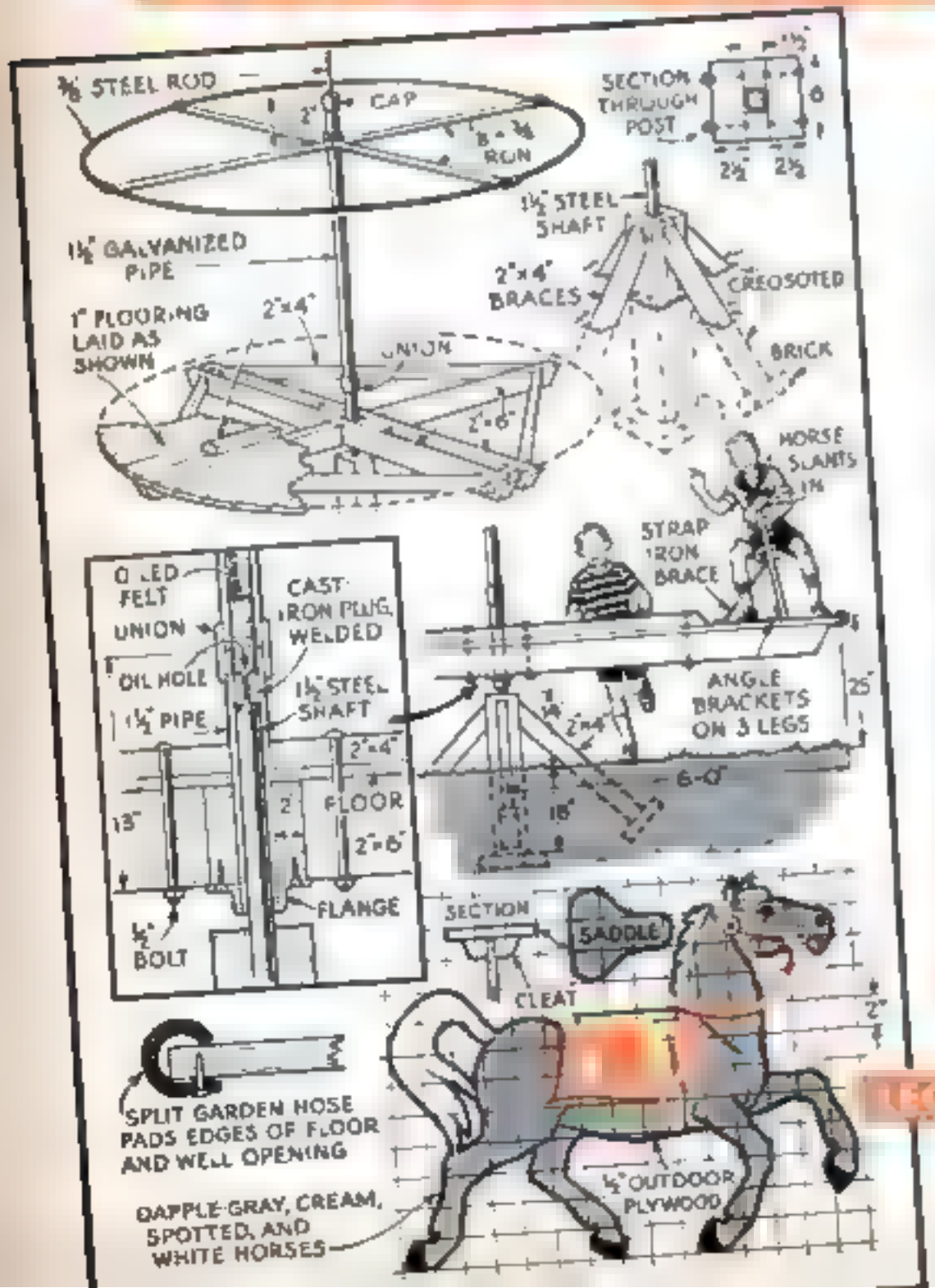
tightly together at all points with clamps or some sort of form and wedges. No screws or other fastenings are needed. The boom may be made in either of two ways as shown in the drawings.

The cabin top is ¼" plywood, and what is left over will be sufficient for the bunks. The cockpit seats and bunks may be arranged as desired. Left-over material and planking will serve for the floor boards. The sheer molding is screwed to the frames with 1½" No. 8 screws and should be put on carefully to assure a pleasing appearance of the sheer line. This completes the hull, which is now ready for sanding and painting.

(To Be Concluded)



BACK-YARD CARNIVAL



By HI SIBLEY

ONE or more of these miniature carnival rides will convert an unused backyard or lot into an unrivaled playground for children. Secondhand lumber may be used to keep the cost low. Dimensions may be modified as necessary to suit the available materials.

Leg-Power Merry-Go. The riders take turns at pushing, but can jump aboard once the platform is in motion. A local garage or machine shop can make the pivot shaft and countersunk plug, the latter with a centerdrilled oil hole. The edges of the platform and well opening are padded with old garden hose. Horses are of ½" outdoor plywood, brightly painted. The canopy may be replaced by a large beach umbrella. A portable radio enlivens the fun with music. If space is lacking, the diameter can be reduced and the various parts scaled down to suit.

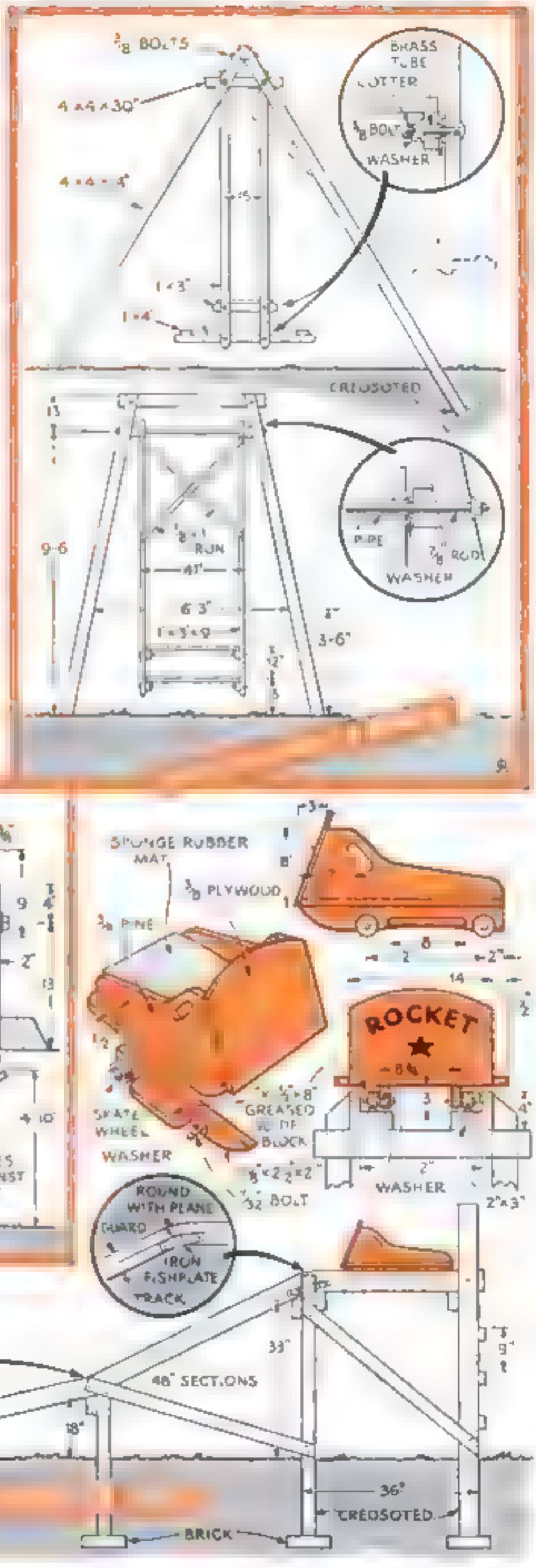
Roll-Coaster Ride. This can be built to fit available space. The car rolls on four skate wheels, side thrust being taken by

LEG POWER MERRY-GO

two greased hardwood blocks. Screw these fast from the inside and round the outer corners well. The starting platform may slope slightly toward the rear to allow riders to mount in safety, the track being blocked so that the car cannot fall off backwards. Check the angles between rail sections for clearance against the wheel blocks to make sure the car will run smoothly.

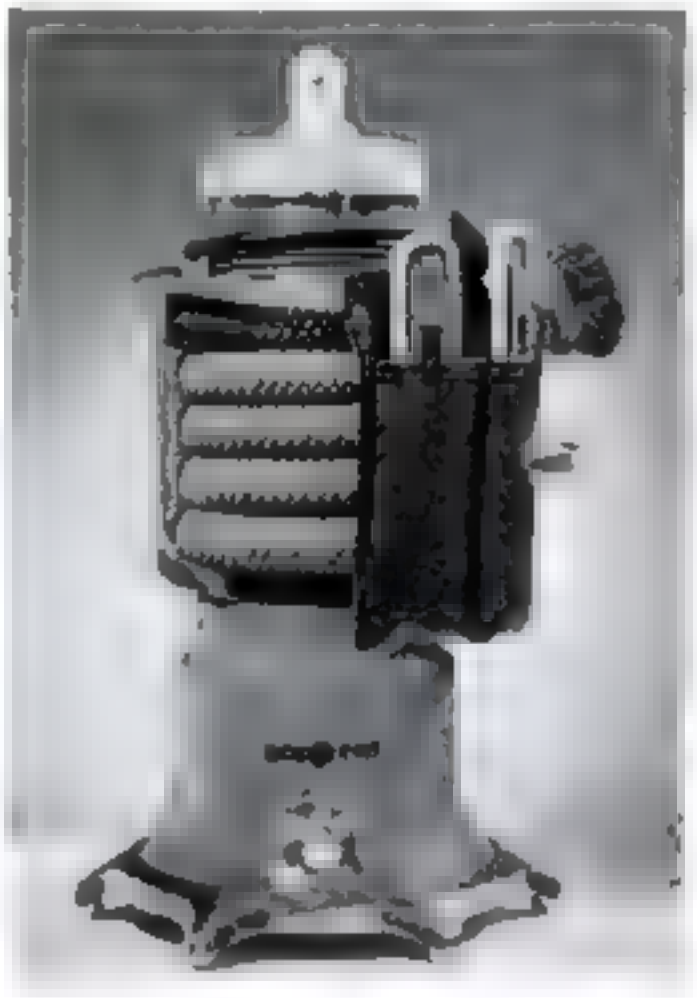
High-Boy Seesaw. This new teeter-totter design combines a high ride with a low center of balance. Two planks are joined by means of side members and rigidly held by long bolts passing both under and over them. Sections of an old tire serve as bumpers, and riders cannot hit the ground as on the conventional seesaw.

Dos-à-Dos Swing. The pantagraph principle applied to this design keeps the seat and foot rest always horizontal. Riders will find it easy to set the swing in motion. Galvanized pipe and two threaded steel rods form the upper bearings. The seat and foot-rest bearings are bushed with brass tube. Diagonal strap-iron braces prevent side sway

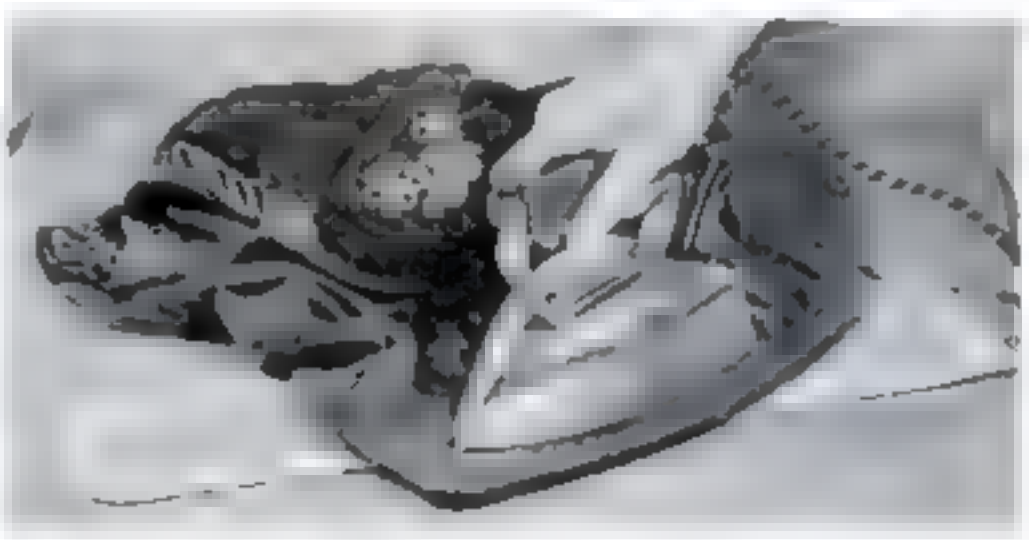


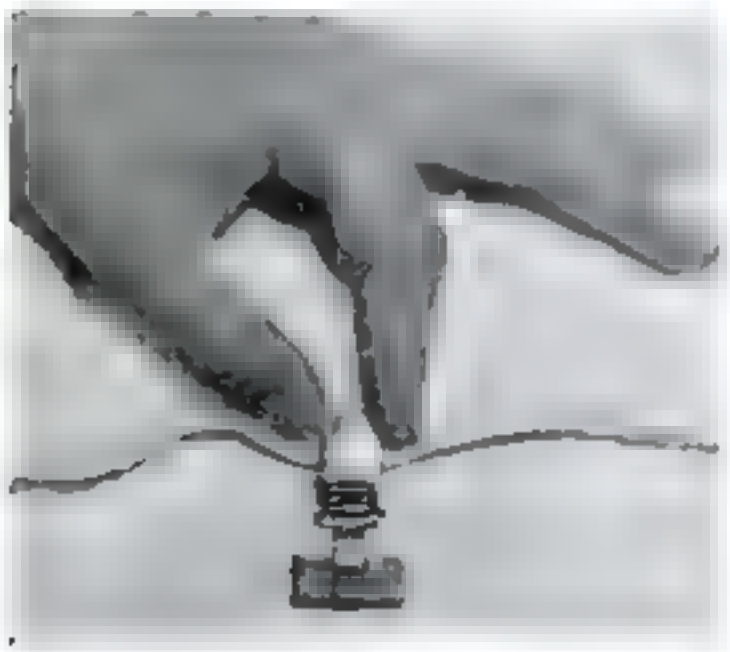
New Appliances

A NOZZLE WITHIN A NOZZLE enables this new vacuum cleaner to remove even hard-to-get dirt and lint. Pressure on the extension-tube handle lowers an inner nozzle, which concentrates suction upon a small area. For general cleaning the outer nozzle is used. Hinged to the handle, it always lies flat and may be used even under low furniture having a floor clearance of less than two inches



TO HOLD SHOWER CURTAINS snugly against the edge of the tub and prevent water from splashing out upon the floor, there is now on the market an ingenious retainer consisting of a clip attached to a small but powerful bar magnet. It will hold on any bathtub made of ferrous metal, even though the latter be coated with enamel or porcelain. Photo below shows comparative size of parts

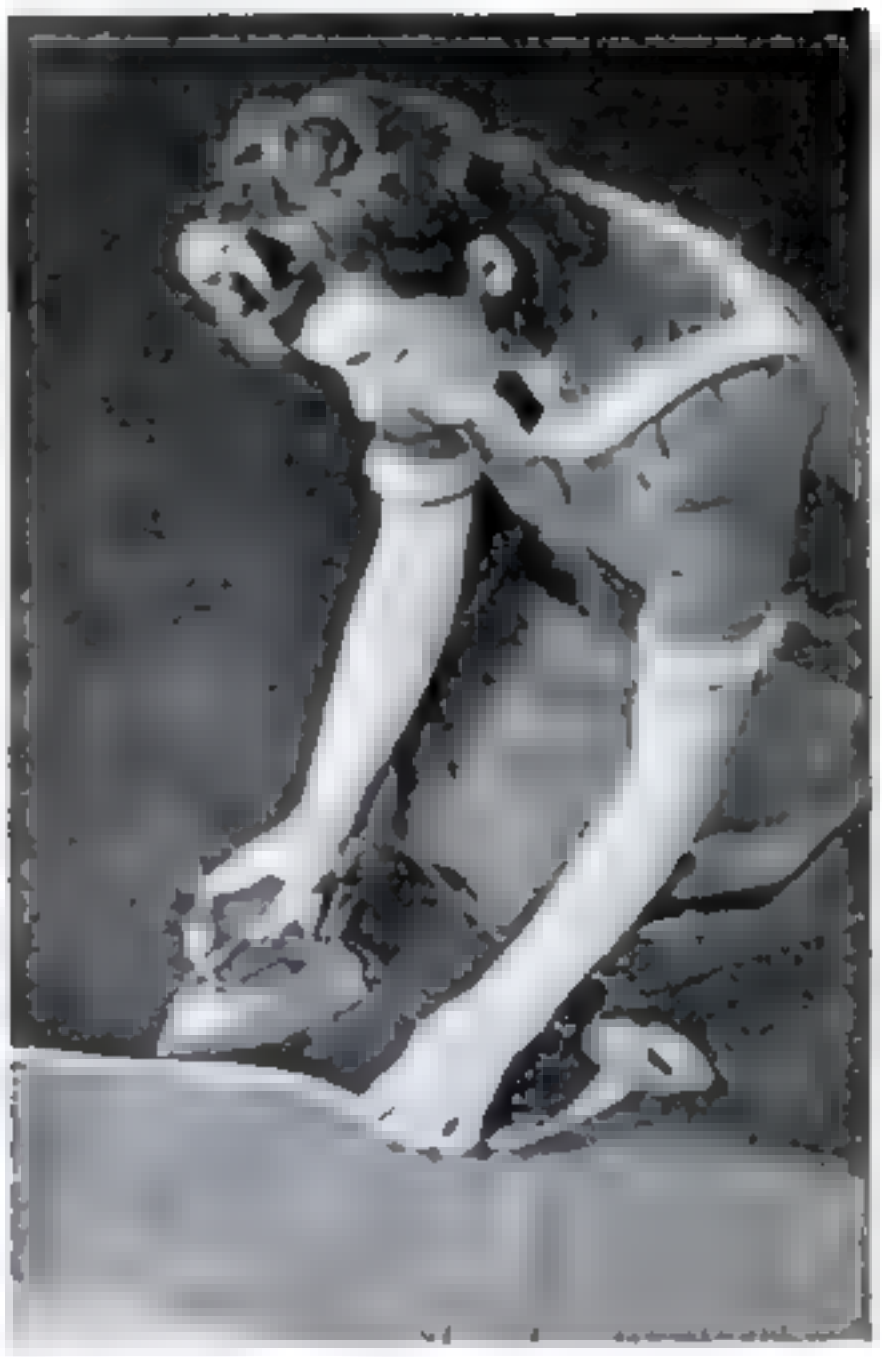




THE VELVET PRESSING BOARD above makes it easy to iron out wrinkled velvet dresses without steaming. This device consists of a piece of heavily padded canvas from which project hundreds of tiny wire bristles one eighth of an inch long. The velvet is placed nap down upon these and ironed on the wrong side. The bristles cannot harm even delicate fabrics, but prevent matting of the nap such as would occur if the velvet were ironed against a smooth surface. A special brush is available to clean the bristles of lint after use

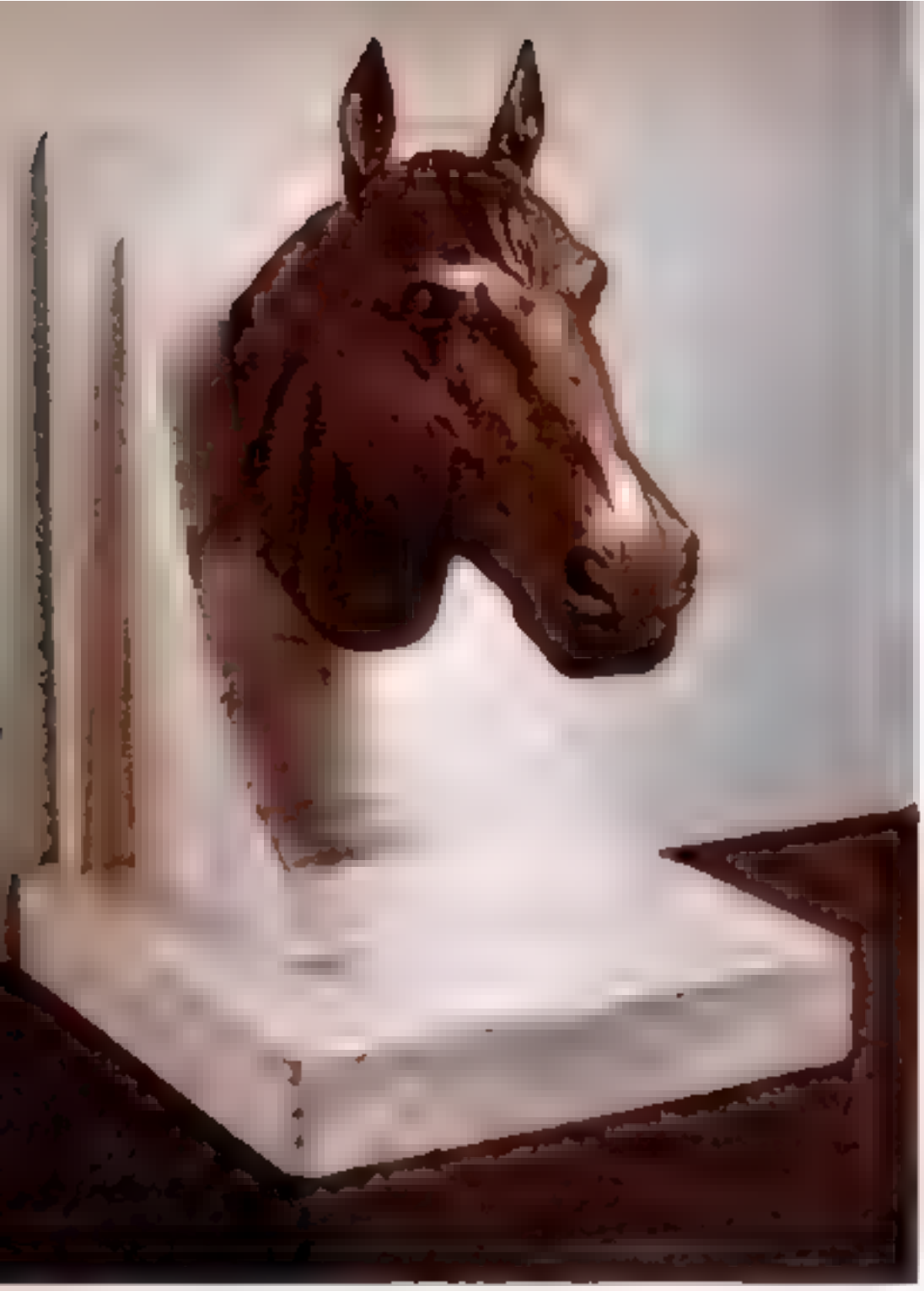
for the Household

GUMMED RUG BINDING, costing but a few cents a yard, affords a simple way of repairing frayed carpet seams and edges. It is attached by ironing, as shown at right, and the bond is not affected even by washing. No water or adhesive is required. Available in green, blue, black, wine and in two shades of brown, it may also be used for binding rug cushions or repairing paper or fabric articles



A NEW BUTTER CONDITIONER is now featured in certain refrigerators. The temperature of this compartment may be independently adjusted to keep butter fresh but at the correct consistency for spreading, so that it may be used immediately upon being removed. A door seals out odors, and electrical heating coils maintain the desired temperature

MADE OF ALUMINUM, this new baking aid not only sifts flour any desired number of times without the use of extra containers, but also thoroughly mixes dry ingredients. To resift, the screen is reversed by a twist of the handle, and the entire assembly turned upside down. Both covers have measuring indications. Its construction makes the sifter very easy to clean



Horse-Head Book Ends

By HOWARD MUNNS

CARVED horse heads make these wooden book ends especially appropriate for a man's room, although they are equally suitable for use in library or living room. The heads themselves are a challenging, but not too difficult, project in hand carving. Those illustrated were made of mahogany; the book ends proper of primavera, a warm, straw-colored South American wood. Walnut could be used for the heads, and nicely grained maple or satinwood in place of primavera.

The curved blocks upon which the heads are mounted should be band-sawed from four thicknesses of ¾" stock glued together, and dressed down ¼" on each side to a final thickness of 2½". Clamp to the base and back, and drill for screws as shown. The upper screw holds the head in place.

In carving the heads, a beginner will do well to use cardboard templates. Mark the profile of each head upon a block of 1½" thick mahogany. Have the grain run parallel with the ears in order to leave these as strong as possible. Cut out the blocks on a band saw, outside the line. Draw a median or center line around the blocks, and mark the template lines across the top and sides.

Start carving on one side of a head only, leaving the other flat as a reference plane for the templates. Refer to the photographs when shaping the sides. Finish one side completely before starting the other, then carve so that the head is symmetrical when viewed from the top and front.

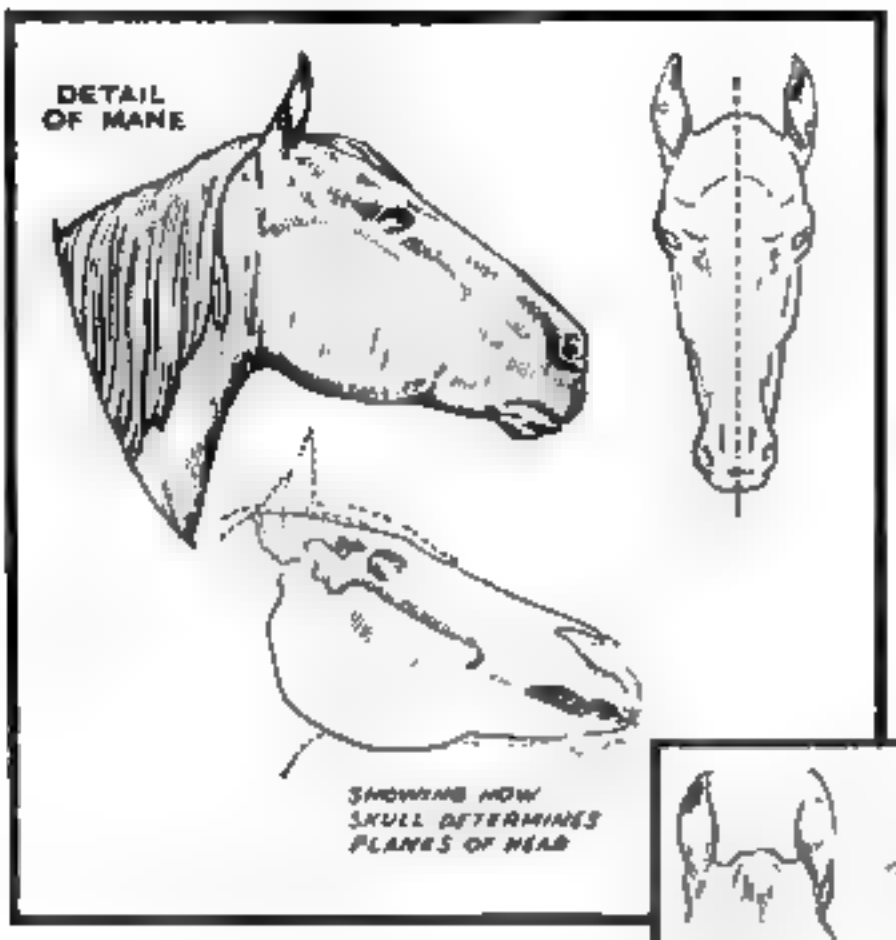
In carving, remember that the widest part of the head is just behind the eyes. The head tapers from there to the nose and, less sharply, from the eyes to the ears and back of the head. The top of the nose is a narrow ridge, broadening to an almost flat surface between the eyes. Under each eye is a definite ledge which ends abruptly at a point one-third of the distance between eyes and nostrils, as shown by template II and in the side views.

The mane is carved with a V-gouge—on one side only, of course. Make the lines long and flowing, starting at the bottom and ending at the top center line of the neck. Use an informal, realistic treatment. Allow a few strands to lie over the main mass of hair. Stain the mane and forelock a walnut color. The head proper may be darkened, if desired, with mahogany oil stain.

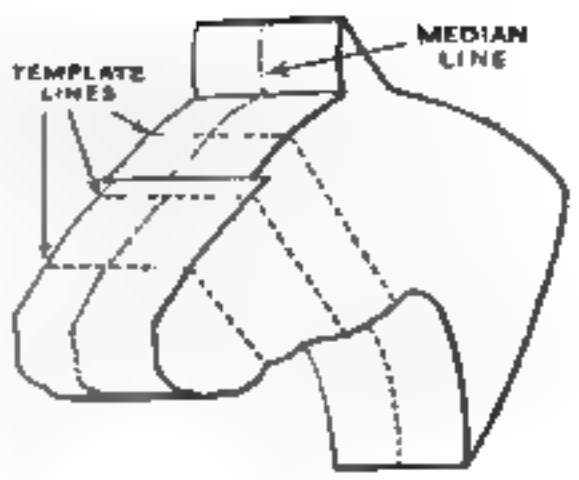
The head should be sanded to an accurate fit against the curved block. This is best done on a power sander. Assemble head and body parts with glue and fasten with screws. To increase the weight, one or more ½" holes may be bored into the base from the back and filled with molten lead.

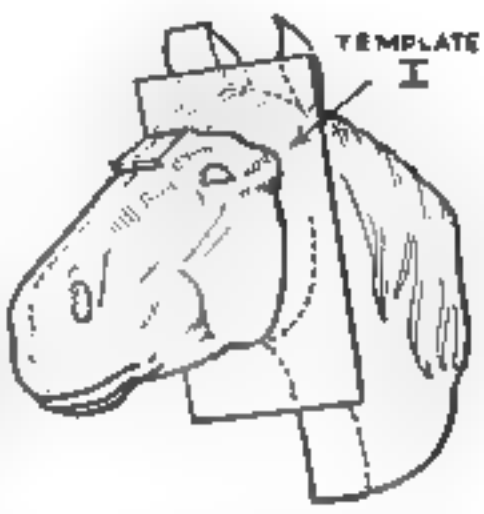
Finish both bodies and heads with two or three thin coats of white shellac to which has been added just enough orange shellac to produce a warm tone. Rub well with very fine steel wool between coats. Apply paste wax all over, allow it to dry for a few minutes, and polish to a satiny luster.

The screw holes may be plugged, or felt may be glued to both the bottoms and backs to conceal the screw heads and protect books and furniture. Surfaces to which felt is to be applied should not, of course, be waxed.

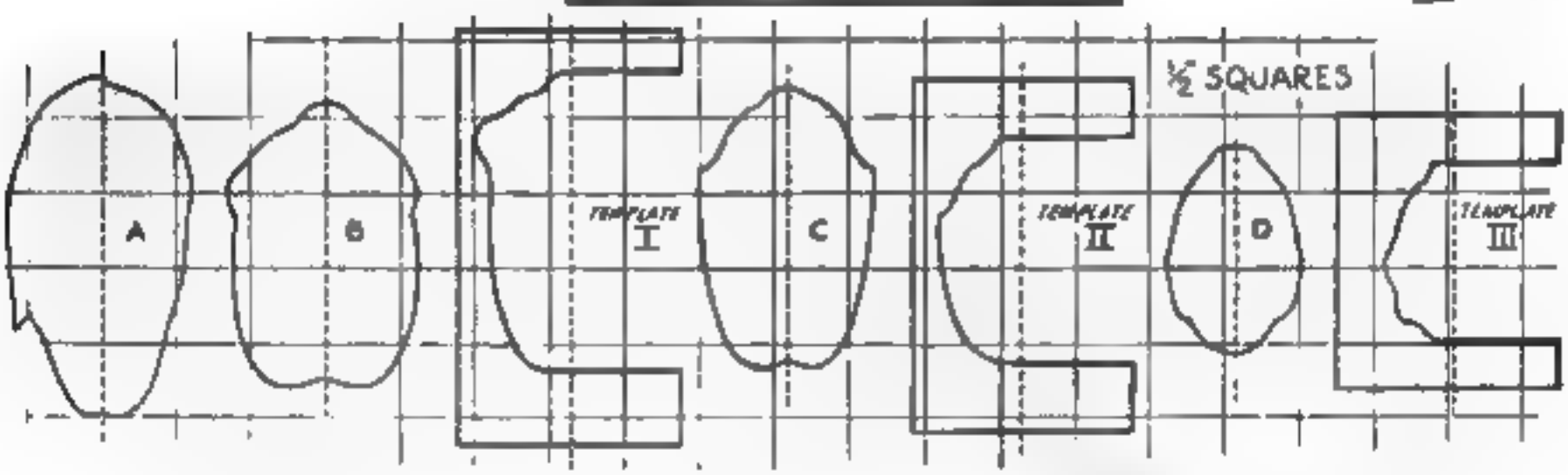

DETAIL OF MANE
SHOWING HOW SKULL DETERMINES PLANES OF HEAD

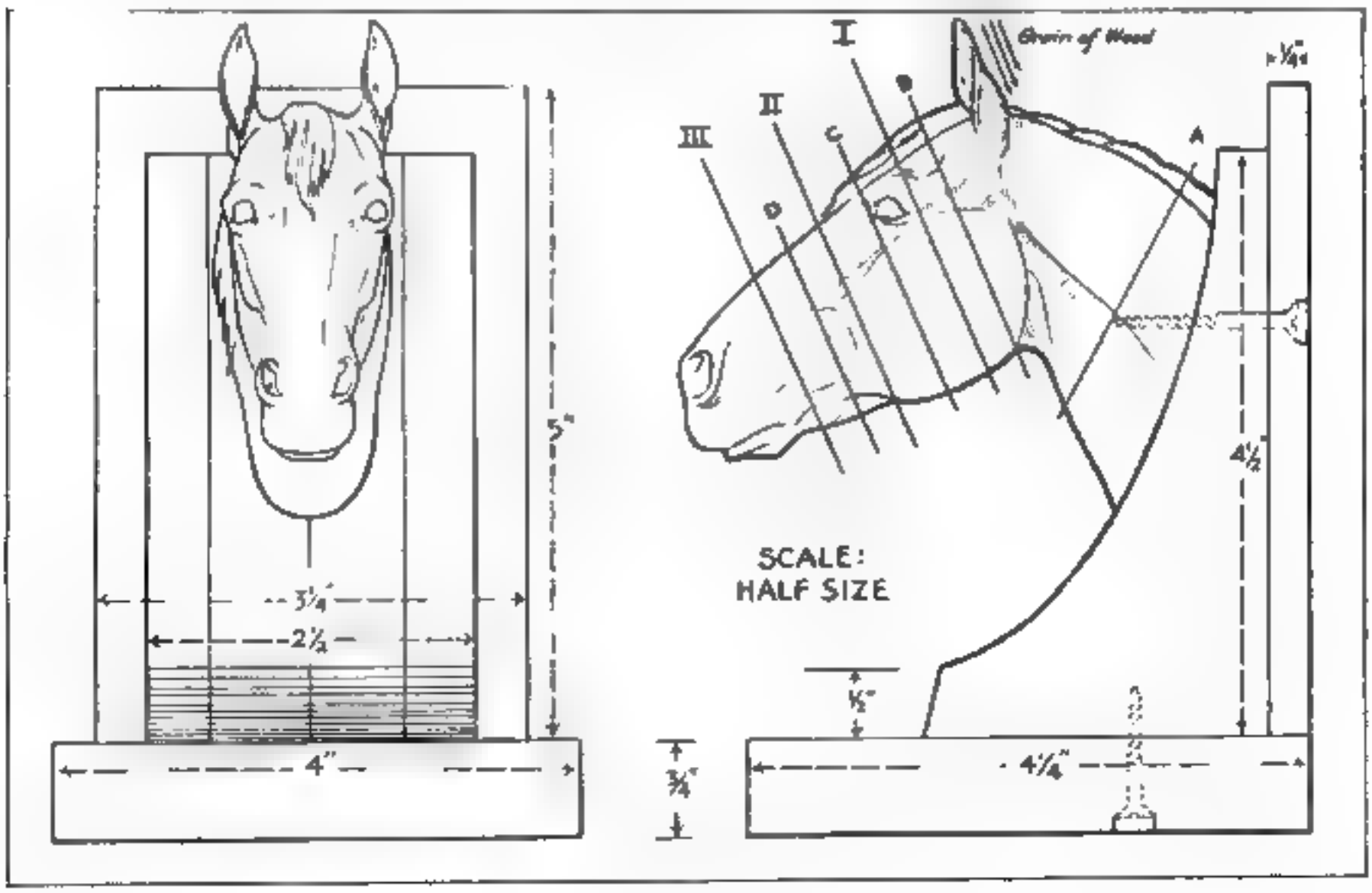

FIRST CUT IN SHAPING SIDE OF HEAD

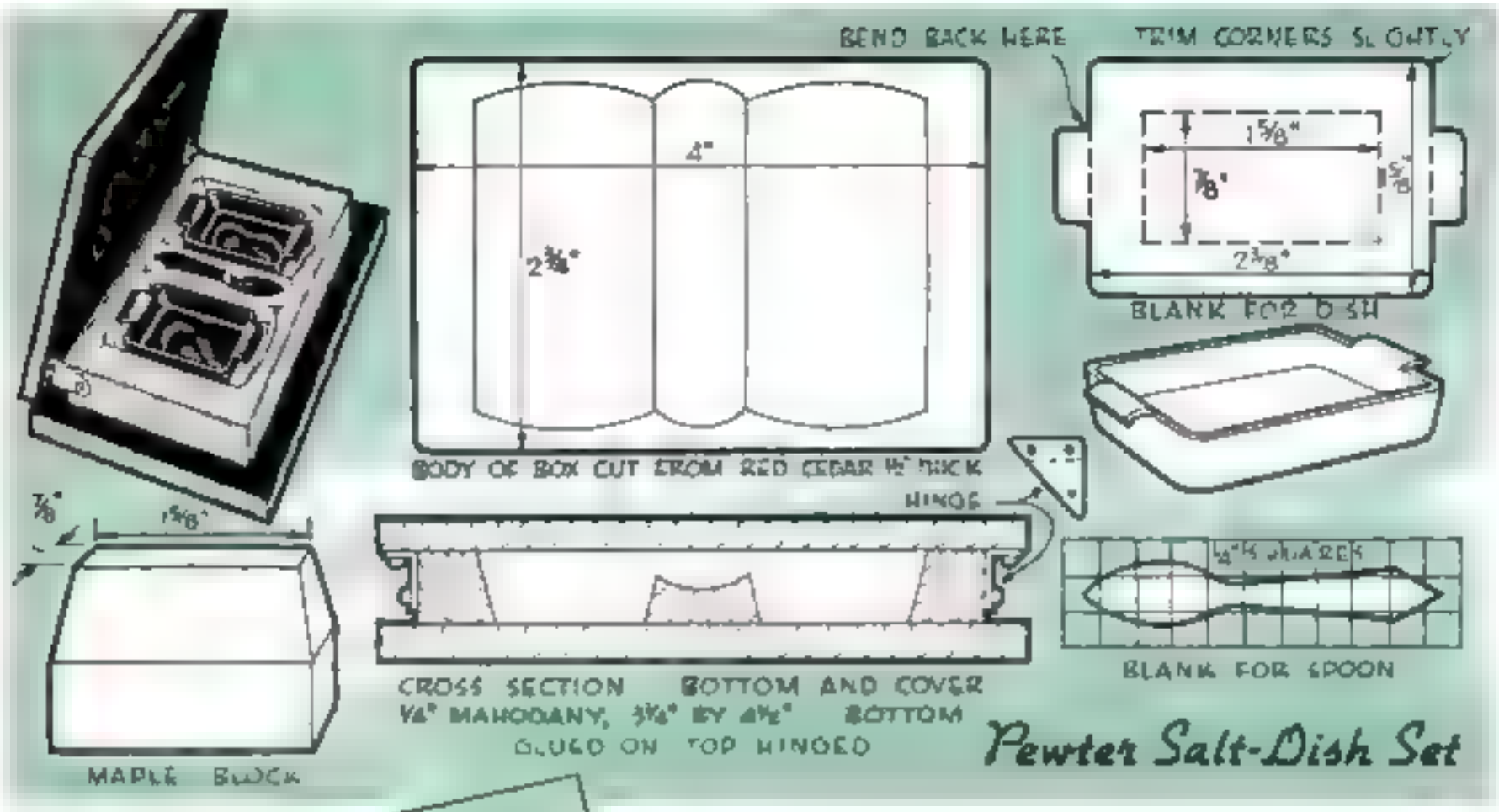

TEMPLATE LINES
MEDIAN LINE

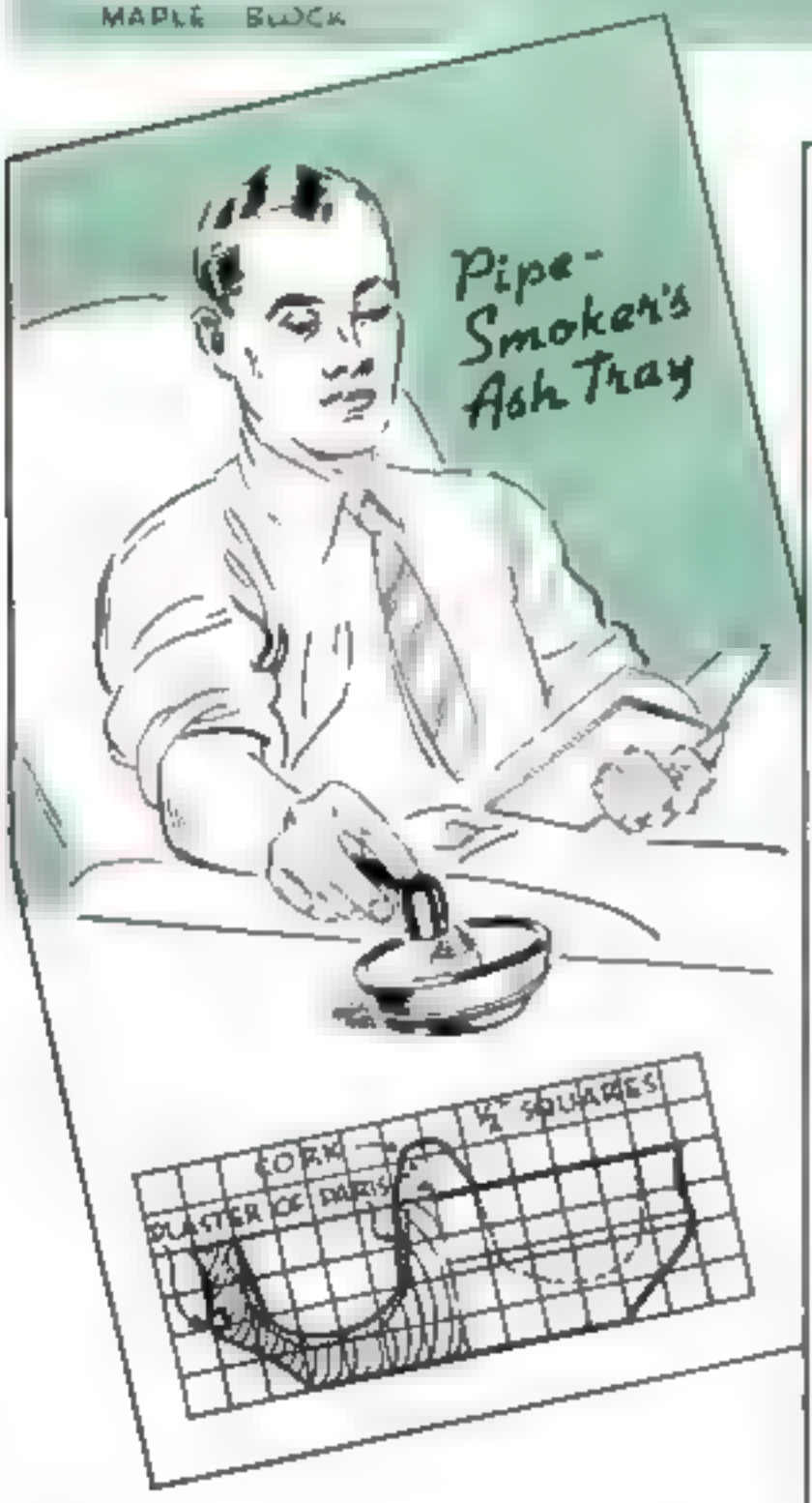

TEMPLATE I


FRONT VIEW OF EARS
SIDE VIEW OF EARS
REAR VIEW OF EARS


½ SQUARES
A
B
TEMPLATE I
C
TEMPLATE II
D
TEMPLATE III


I
II
III
Grain of Wood
3¼"
2½"
5"
4"
SCALE: HALF SIZE
½"
¾"
4¼"
4½"



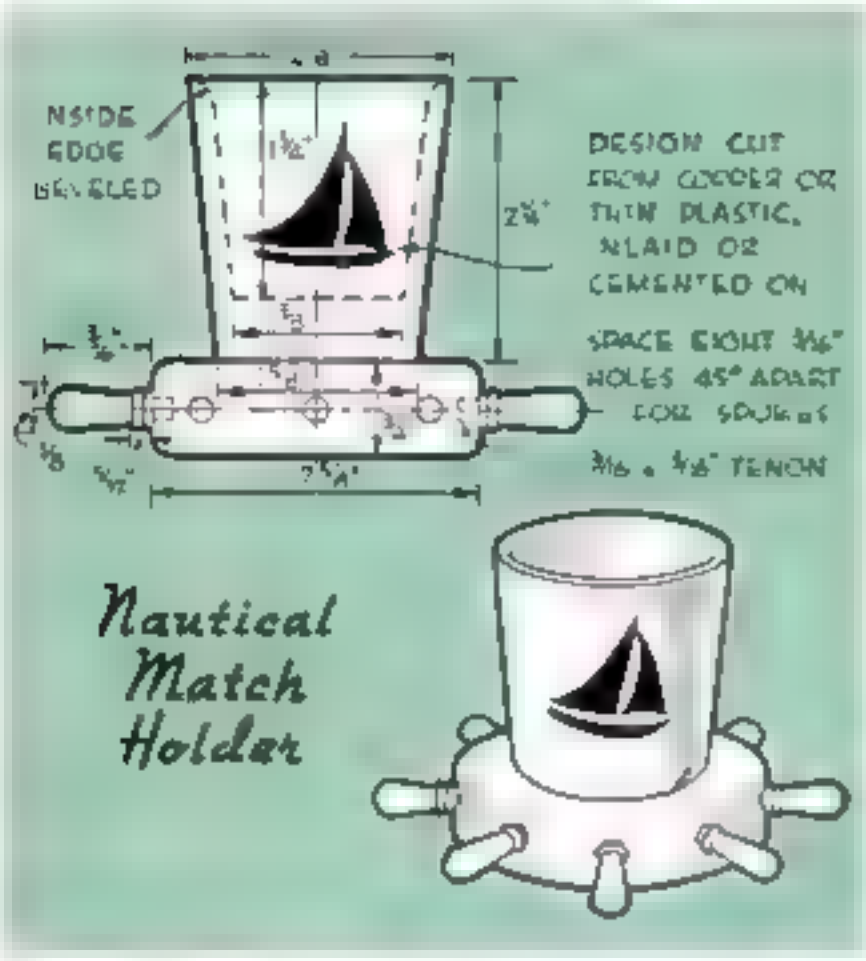


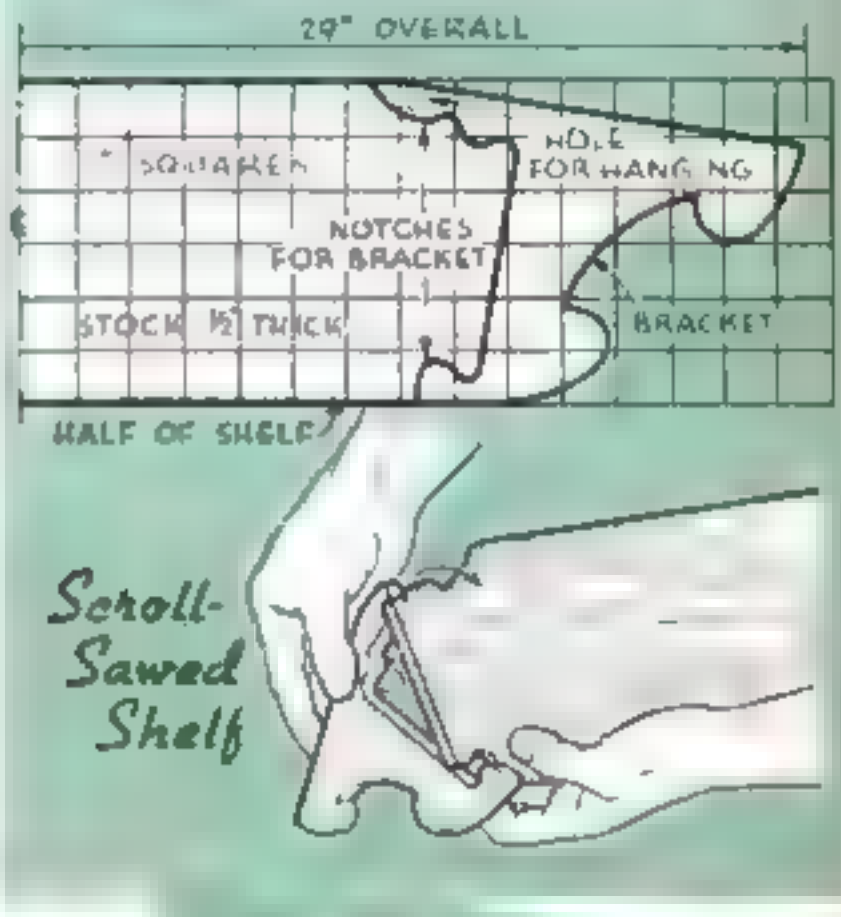
These five projects require little material, yet the finished articles are both useful and attractive. The shelf at the top of the facing page, for example, can be jig-sawed entirely from a single board

WORKING TIME:

PEWTER SALT-DISH SET. Collectors are on the alert to find antique salt-dish sets, but any amateur craftsman can make a decorative one of his own from pewter. The dishes are hammered from 18-gauge over a tapered maple block. Care should be exercised not to allow the metal to buckle. Trim the edges and bend the handles back. The salt spoons are hammered, bent to shape, and smoothed with a file. A pair of dishes, if packed in a neat box, make an attractive wedding gift. Average time, each salt dish, ⅝ hour; each spoon, ½ hour; box, 2 hours.

PIPE SMOKER'S ASH TRAY. Turn the tray to shape and remove it and the faceplate together from the lathe. Mix plaster of Paris with water to which a little vinegar has been added; the consistency should be a little softer than putty. Pack the plaster tightly into the tray. Mix some fresh plaster to fill out the dovetail groove around the outside. Cut a large cork in half and glue one piece to the knob in the center of the tray. Clamp until the glue is dry, then remount the faceplate on the lathe, turn the plaster lining smooth with a gouge, remove excess plaster around the groove, and turn down the cork. Sand smooth and finish the wood as desired. After being used, the plaster lining turns brown like meerschaum. Craftsman's time, 2½ hours; beginner's, 3½ hours.



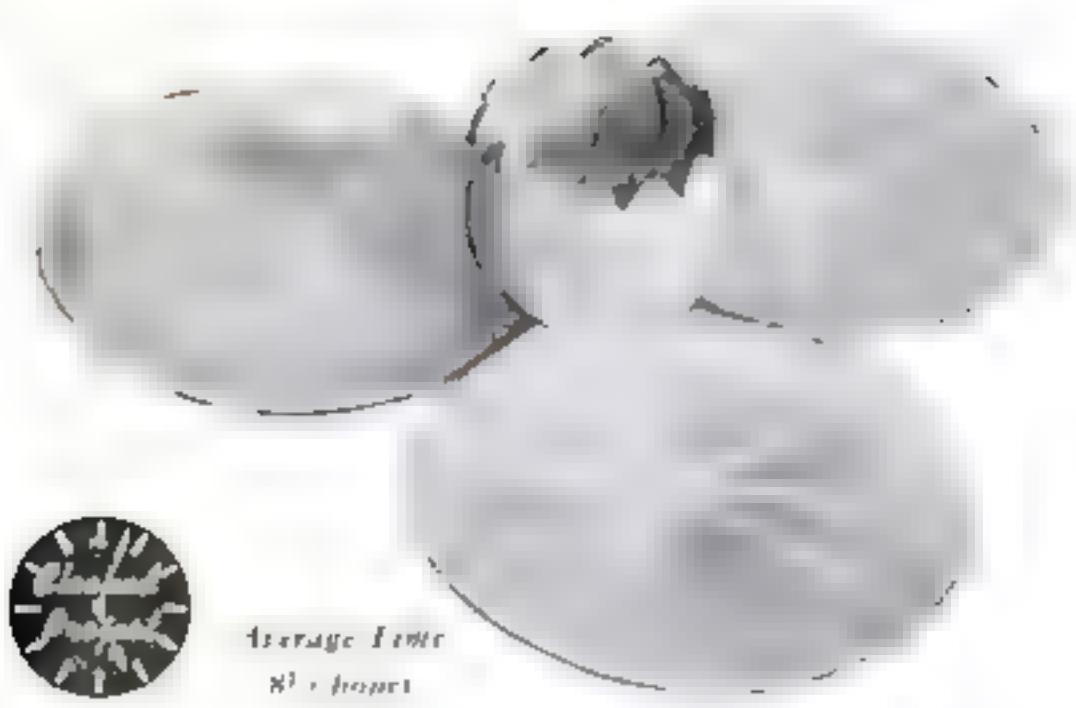


ONE EVENING

NAUTICAL MATCH HOLDER. This salty little piece can be turned from any nicely grained hardwood. Shape the outside of the cup between centers, then mount on a screw center or faceplate to turn out the inside. The two parts may be fastened with a single countersunk screw or glued together. Spokes are turned four at a time and spaced 45 deg. apart. Varnish and wax inside and out. A design cut from copper or thin plastic may be added. Craftsman's time (not including design), 2¾ hours; beginner's, 4 hours.

SCROLL-SAWED SHELF. Both the shelf and its supporting brackets are cut from one piece of wood ½" by 6" by 29". The parts are assembled without glue, dowels, nails, or screws. Black walnut was used for the shelf illustrated, but any wood will serve. Craftsman's time, 1½ hours; beginner's, 2¼ hours.

RACK FOR TOASTING FORKS. Early American toasting forks, ladles, and similar long-handled antiques can be displayed beside the fireplace on this Colonial rack. The forks hang on brass nails set in the edge of the shelf, upon which a Betty lamp, candlesticks, or match box can be placed. Craftsman's time, 1½ hours; beginner's time, 2¼ hours.



Average Time
8½ hours

HAMMERED ALUMINUM RELISH DISH

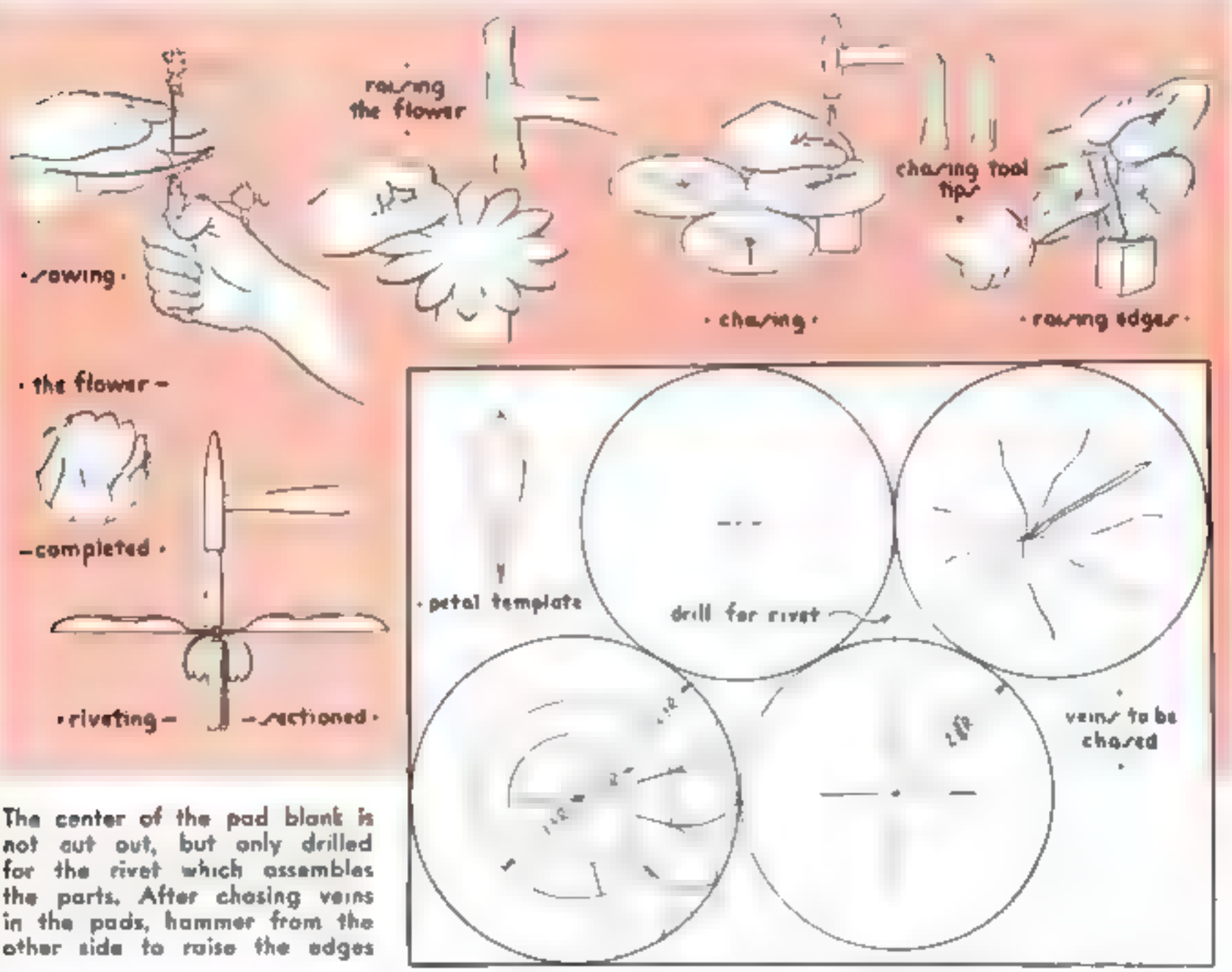
WHEN not in use, this water-lily relish dish makes an attractive table centerpiece, especially if placed upon a round mirror of suitable size.

The twelve-petaled lily and the blank for the pads are cut from 16-gauge aluminum with a jeweler's saw, and the edges filed and further smoothed with emery cloth. For shaping, which is done against the smoothly cut end grain of a maple block, a forming hammer is best, but a highly polished ball-peen hammer can also be used.

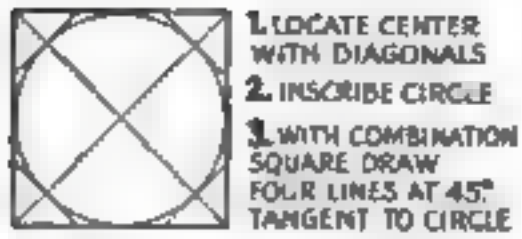
The concave lily petals are shaped one at a time by raising the edges of each, bending them up to overlap evenly.

Tools for chasing the veins in the pads may be made from brass or steel. Flatten the ends to blunt edges, and polish well with emery cloth. Sketch in the veins, and with the chasing tools hammer the metal lightly into a saw kerf cut into a maple block. When the veins have been formed, turn the blank over and raise the edges of the pads.

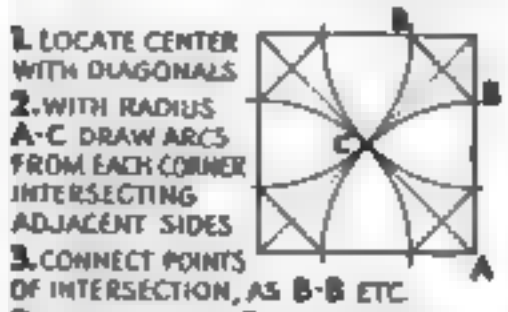
Remove tool marks by filing, and clean the file after each stroke. Polish with emery cloth and fine steel wool. Assemble with an aluminum rivet.—TOM E. MOORE.



The center of the pad blank is not cut out, but only drilled for the rivet which assembles the parts. After chasing veins in the pads, hammer from the other side to raise the edges

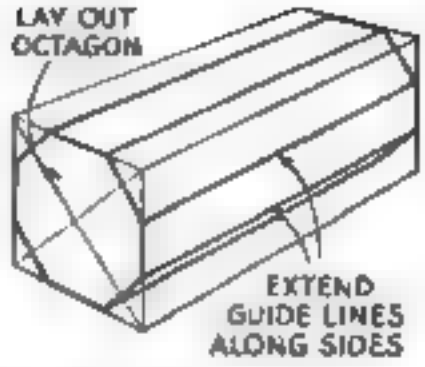


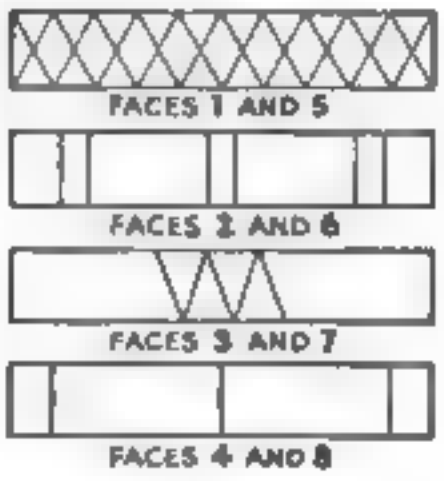
1. LOCATE CENTER WITH DIAGONALS
2. INSCRIBE CIRCLE
3. WITH COMBINATION SQUARE DRAW FOUR LINES AT 45° TANGENT TO CIRCLE



1. LOCATE CENTER WITH DIAGONALS
2. WITH RADIUS A-C DRAW ARCS FROM EACH CORNER INTERSECTING ADJACENT SIDES
3. CONNECT POINTS OF INTERSECTION, AS B-B ETC.

Two Ways to Lay Out Octagon





For fair competition, the eight-sided roller must be accurately cut. The markings may be incised and filled with enamel

Curious Old English Game Revived for Home Entertainment

THIS game, which is derived from one that was popular in Old England during the Christmas season, will entertain the entire family. An octagonal umbrella handle or similar object may be used for the roller, or it can be made of wood, bone, or plastic of any convenient size. The one shown is of ruby plastic, 1½" across the flats and 3½" long. Be sure the faces are of precisely equal width and each is at 135 deg. to the adjoining faces. The markings may be painted, incised, or inlaid. Those on opposite faces are alike. Craftsman's working time (wood), 1½ hours; beginner's, 2½ hours.

The players are provided with counters, beans, matches, or the like. To start the game, each contributes a like number of these to a pool. The "Long Lawrence" is rolled by each player in turn. If face 1 rolls uppermost, it is a flush, and the player takes the entire pool. Face 2 obliges him to put down two counters. Face 3 leaves the stakes unchanged, and the roller is passed to the next player. Face 4 entitles the player to pick up a counter from the pool. The original names for the four throws are, "flush," "put down two," "lave all," and "sam up one." It adds interest to use these.

RUBBER-STAMP METHOD

[*METAL ETCHING—6*]

Where a rubber stamp is to be used in etching letters, designs, trade-marks and the like on metal, the following method saves time:

Paint the metal with a thin, even coat of asphaltum varnish and let dry. Saturate a piece of blotting paper with lacquer thinner. Press the rubber stamp upon it just enough to wet the printing surface of the rubber; then hold the stamp firmly against the asphaltum-coated metal for a few seconds, during which the lacquer thinner will "cut" the varnish. If too much thinner is taken up on the stamp, it will obliterate the outlines of the letters. A little experimenting will show the right amount to use.

Brush the metal surface lightly with water to remove loosened varnish, apply the etching solution, and let it etch to the desired depth. The acid is best applied with a cotton swab, and should be carefully kept off fingers or clothing.

For copper and brass, use clear commercial nitric acid. For aluminum use one part water to two parts muriatic (hydrochloric) acid. A mixture of one part nitric acid and one part muriatic acid will successfully etch steel.

When the etching is complete, wash the metal and remove the asphaltum with kerosene or lacquer thinner.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

Slide-Rest Shaper

A TIMESAVING ATTACHMENT TO BUILD FOR YOUR LATHE

By C. W. WOODSON

This little shaper, mounted on the cross slide of a lathe, will finish many small parts that otherwise would require tedious filing by hand

MOUNTED on the cross slide of a lathe in place of the compound rest, the shaper attachment shown in Figs. 1 and 2 will finish many small parts that require planing, shaping, keyway cutting, or slotting—work that ordinarily would have to be done by tedious hand filing in shops with limited equipment. It will also save labor in those types of tool, die, and model work that require the cutting of semicircles and square holes, or the shaping of internal gears, punches, dies, and other intricate work. The many uses to which this versatile accessory can be put in difficult shaping of these types will well repay the time and effort required in its construction.

The first essential is a suitable worm-geared motor to drive the ram at the proper speed. This should be in the neighborhood of, but not over, 200 strokes a minute. The tool will work best at this or a lower speed. The motor shown was specially built and is not on the market, but a number of other motors quite similar to it are available. This type of motor is fairly expensive, and if a used one can be obtained the saving will be well worth while

With the motor on hand, work can be started on the pattern for the base. The motor output shaft should be located at right angles to the ram stroke, and the base shaped to fit the motor mounting. This pattern is cut out on the jig saw, the hole for the column shaft being sawed with the table tilted to provide the necessary draft. No core is necessary if the hole has enough taper to allow the pattern to be withdrawn from the sand.

The collar for the shaft end of the base is turned with a decided taper, both inside and out. It is glued in place on the base, and the hole sanded until perfectly smooth. The lug for the clamping screw is next cut out and glued in place. Sharp angle joints are rounded out with beeswax fillets run in with a hot rod. If this precaution is not taken, the casting may crack at these corners when cooling

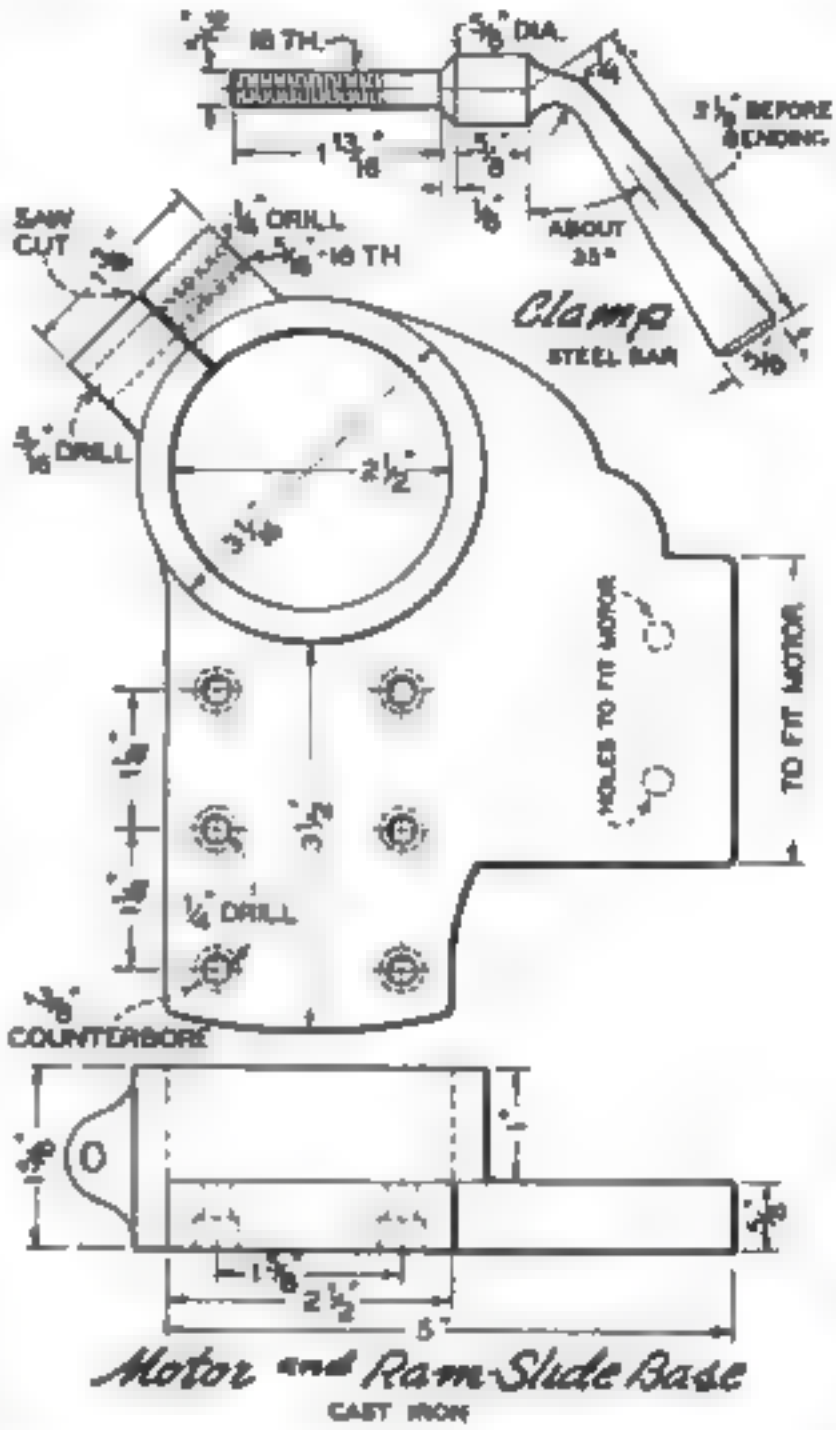
The pattern for the ram is built up around a 13/16" block, and two ⅛" pieces are cut to shape and glued to the sides. These pieces add a streamlined appearance to the ram, but the pattern may be simplified to a plain rectangular shape if desired. The ram could, in fact, be made from a solid bar of brass or steel instead of from a casting. When the patterns have been well sanded and shellacked, they are ready for the foundry.

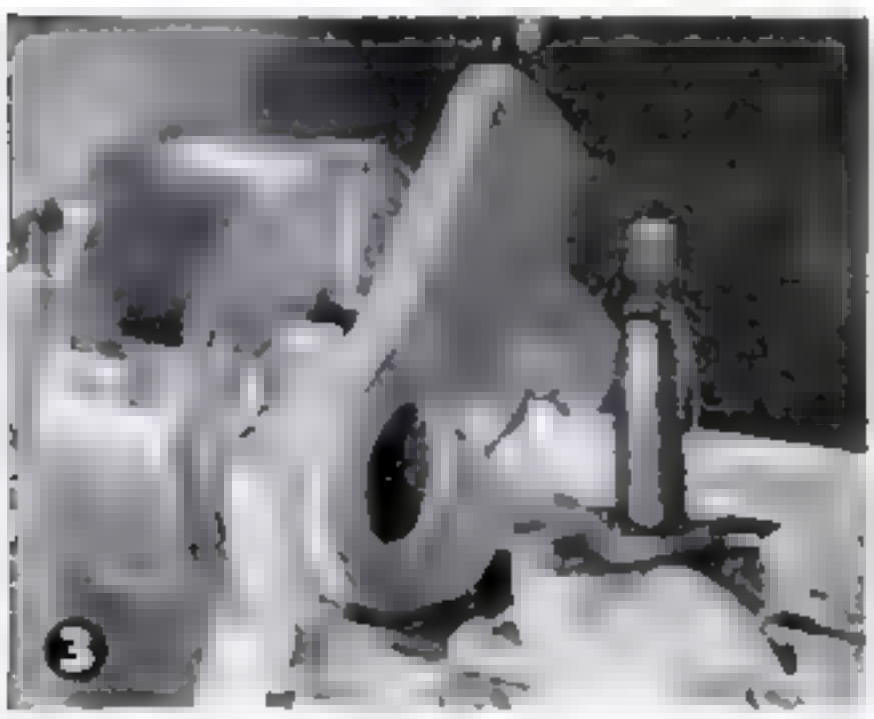
Machine work on the castings is started by chucking and facing off the base as shown in Fig. 3. This part is then clamped to a faceplate, Fig. 4, and the shaft hole bored to size. A light cut is next taken, with the piece held in the milling attachment, for the motor base.

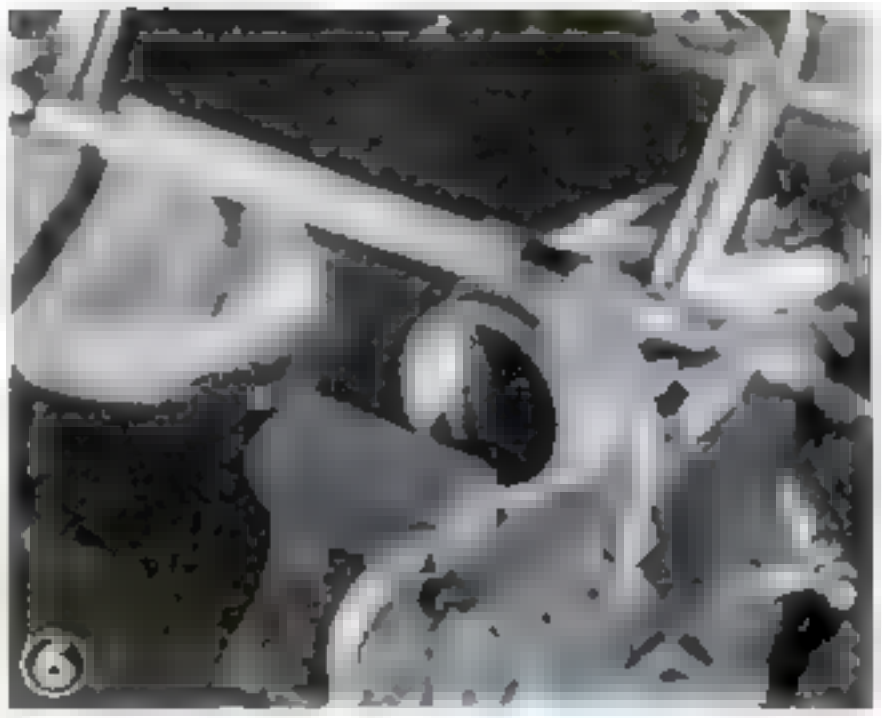
Holes are drilled for the ram-slide screws, the motor screws, and the clamping screw, the latter operation being shown in Fig. 5. The casting is split with a hack saw, Fig. 6, for clamping the shaft. One half of the clamping lug is tapped 5/16"-18 threads per inch, and the other half is cleared with a 5/16" drill. The clamping screw is made from a ⅝" steel bar turned to the dimensions in the drawings, threaded 5/16", and finally bent to shape.

The ram slide is built up from cold-rolled steel flats. In drilling the built-up guides, the steel shoe for the ram is clamped to the ⅜" thick slide plate, and the guides are clamped firmly against the shoe. This makes a snug fit for the shoe and keeps the guides in alignment. Six holes are drilled into the ⅝" plate for fastening it to the base. Either fillister-head or flathead screws will do. Figure 7 shows the base complete with the slide.

In machining the ram, the casting is first chucked and center-drilled for tailstock support. Then the end is faced smooth. The sides and bottom are machined with the part held in a four-jaw chuck, as in Fig. 8. This would ordinarily be done on a milling machine or shaper, but in the absence of



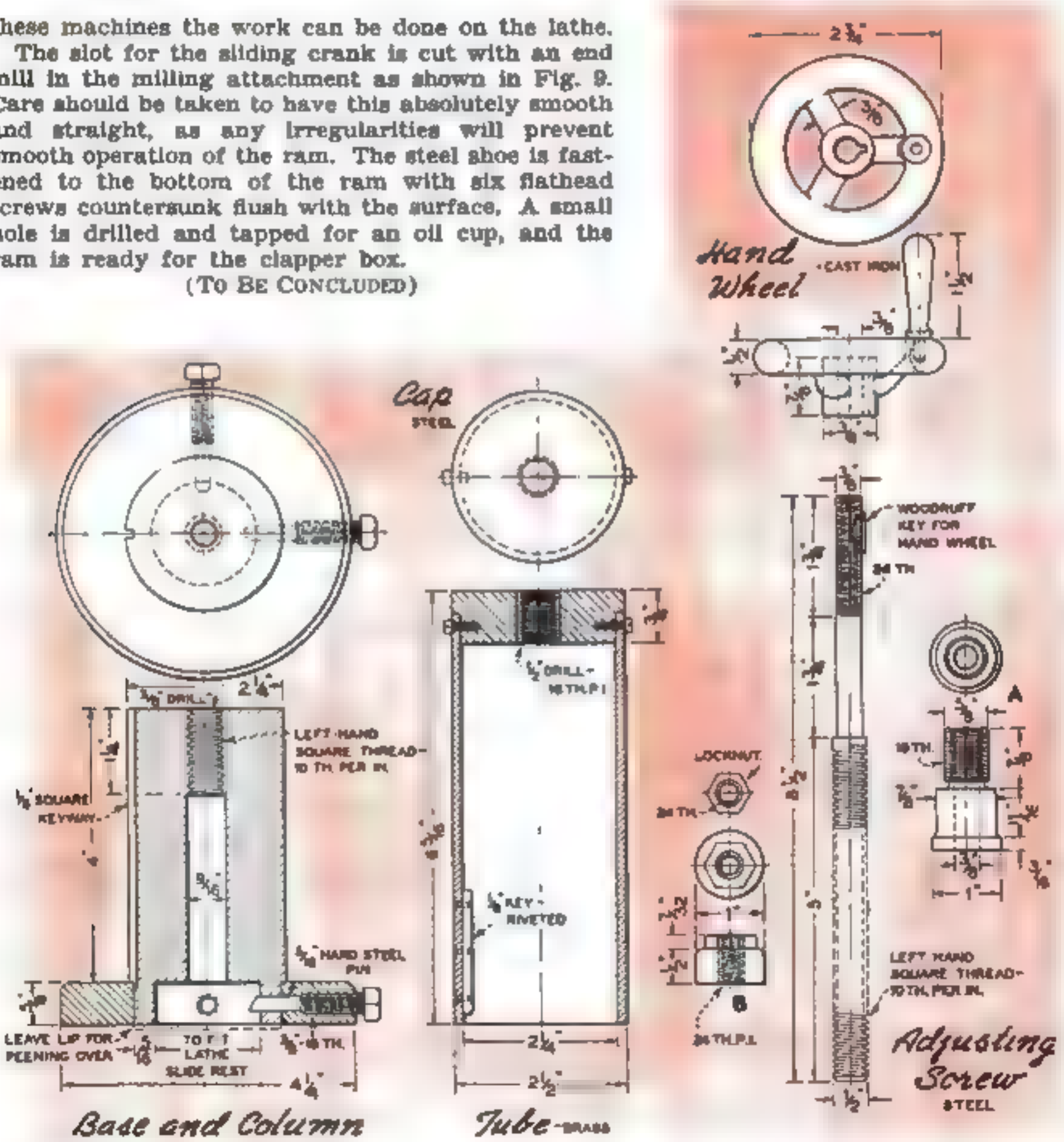


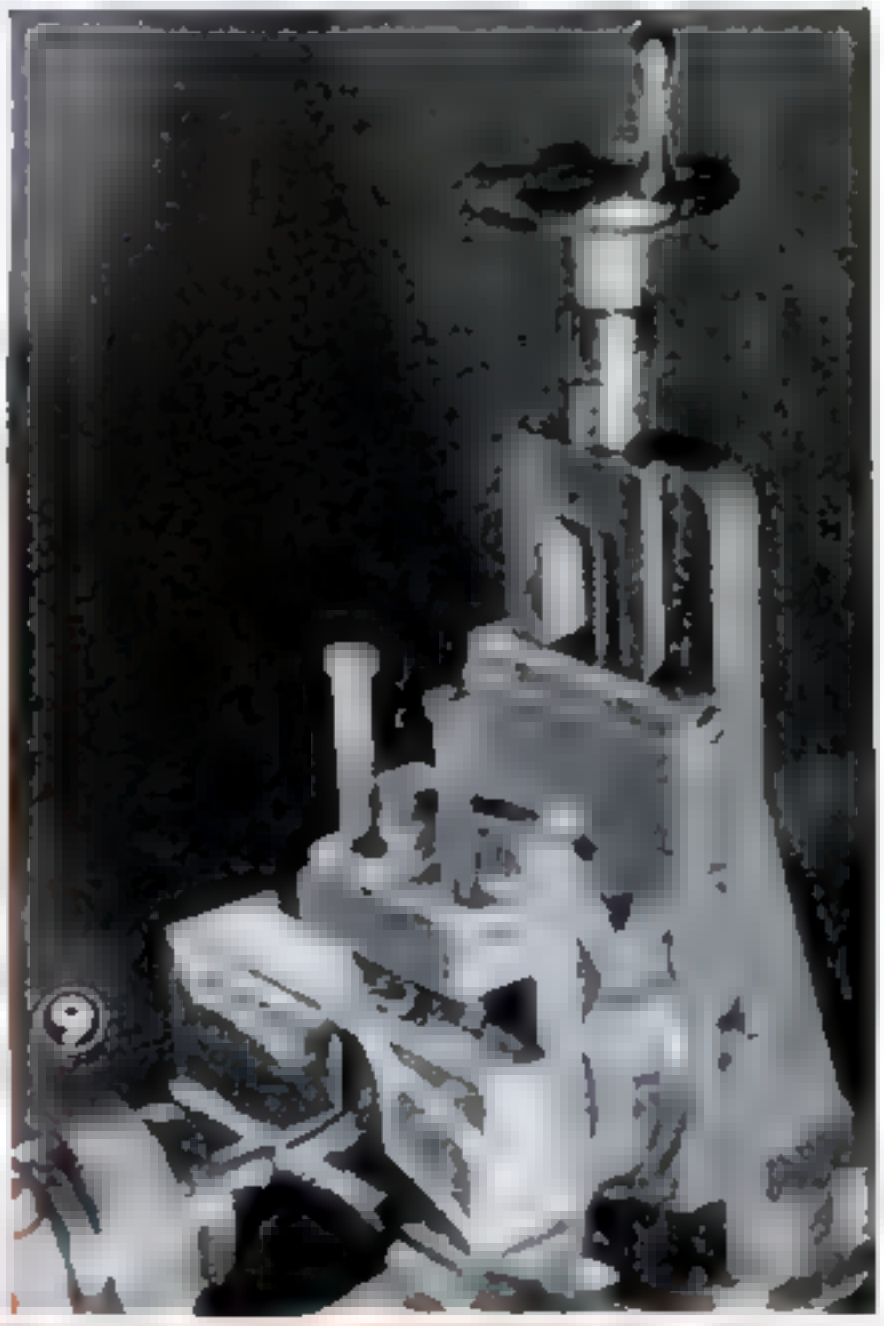


these machines the work can be done on the lathe.

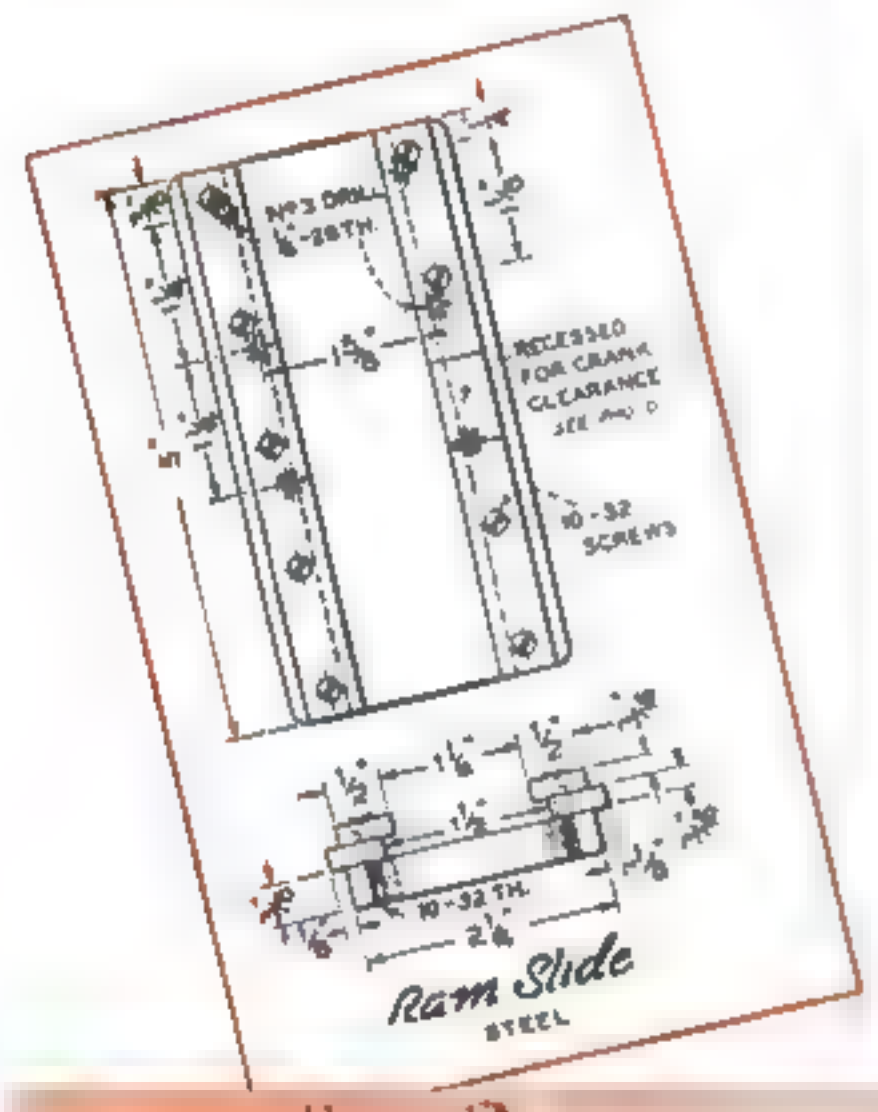
The slot for the sliding crank is cut with an end mill in the milling attachment as shown in Fig. 9. Care should be taken to have this absolutely smooth and straight, as any irregularities will prevent smooth operation of the ram. The steel shoe is fastened to the bottom of the ram with six flathead screws countersunk flush with the surface. A small hole is drilled and tapped for an oil cup, and the ram is ready for the clapper box.

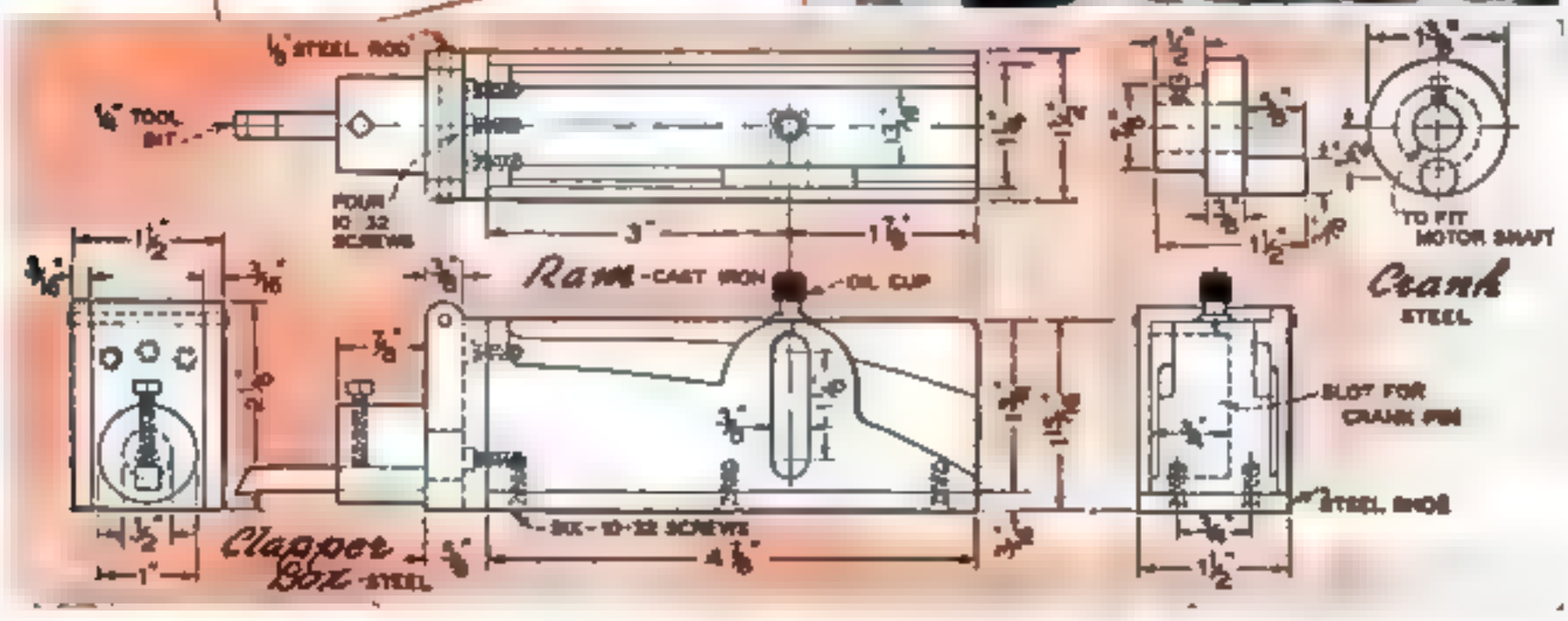
(To Be Concluded)



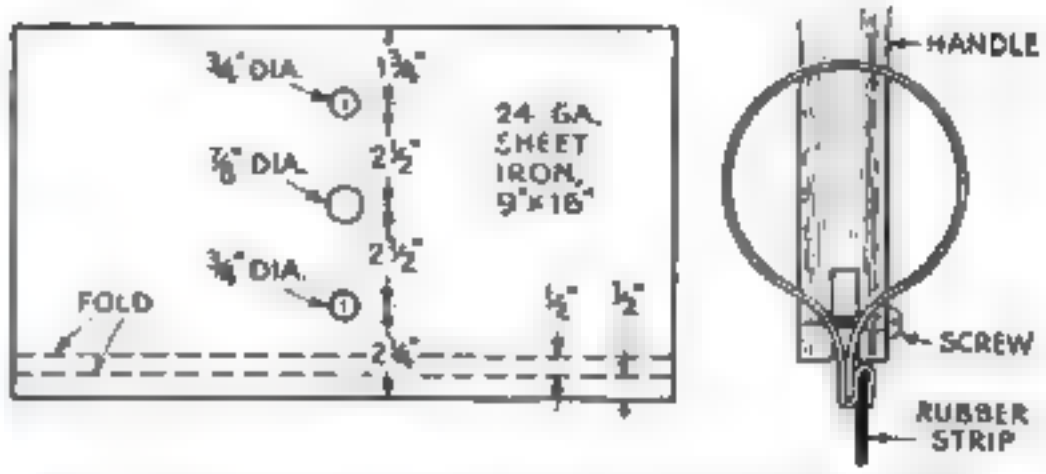


Finished base and slide (above), and two photos showing operations in machining the ram. Below are drawings of slide, ram, clapper, and crank





Efficient Squeegee Sweeper Keeps Workshop Floor Clean



The unfolded edge is securely locked behind the other. Sharp punch indentations help to hold the rubber strip

THIS squeegee will be found excellent for sweeping up shavings and other workshop litter or spreading spilled liquids so that floors will dry more readily. A piece of 24-gauge galvanized iron is drilled and bent as shown, one edge being folded twice along the dotted lines and squeezed shut over a strip of heavy sheet-rubber packing. Make punch marks along one edge to further secure the rubber. On a disk or drum sander bevel the strip to a thin, flexible edge. Slot one end of an old broom or mop handle, insert so that the folded edge of the metal engages the slot, and fasten with a single screw.—BENJAMIN NIELSEN.

Contact Point of Dial Indicator Plated for Greater Durability

CHROME plating the tip of an indicator ball point, if it is not already so finished, will lessen friction between it and the work, add to the accuracy of the contact, and cause the instrument to last considerably longer.—ROBERT RAICH.

GRINDING LATHE CENTERS

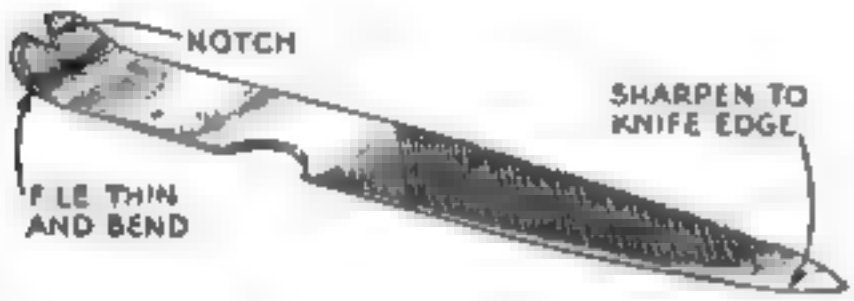
[LATHE WORK—13]

Precision lathe work requires that centers be kept in perfect condition. Centers may be trued with a toolpost grinder as shown. Set the compound rest at 30 deg. See that the wheel runs perfectly true, and adjust the center line of the grinding wheel exactly on the center line of the lathe spindle. If the wheel is too high or too low, the angle produced on the work will necessarily be incorrect. Run the lathe at low speed and the grinder, if possible, in the same direction. Feed the wheel back and forth across the conical face of the center with the compound feed, taking very light cuts (0.002" or 0.003"). Test with center gauge. Remove the sharp point with a touch of the grinding wheel. Protect the lathe ways from grinding dust by covering them with cloth or paper.

POPULAR SCIENCE MONTHLY SHOP DATA FILE

Wide Half-Lap Joints Quickly Made with Aid of Jointer

MANY circular saws cannot be set for a sufficiently deep cut to make half-lap joints on wide stock. Usually the cut is finished with a handsaw, but if a jointer is available the work can be done more quickly as follows: Make the shallow cut across the grain on the circular saw in the usual way; then set the jointer to the required depth, and feed the stock across the cutting head with a hold-down or push stick such as shown above. This removes all the waste, leaving the joint ready to be assembled. Note the saw cut in the partly finished joint at the left.—R. O. LISSAMAN.

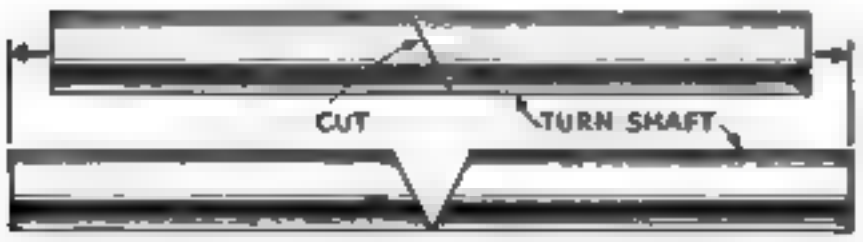


Thumb-Tack Lifter and Knife Ground from Nail File

A HANDY tool for draftsmen and artists may be made from a small nail file as shown above. The notched end is used for prying up thumb tacks, and the knife edge at the pointed end for erasing errors and trimming paper and tracing cloth.—D. E. L.

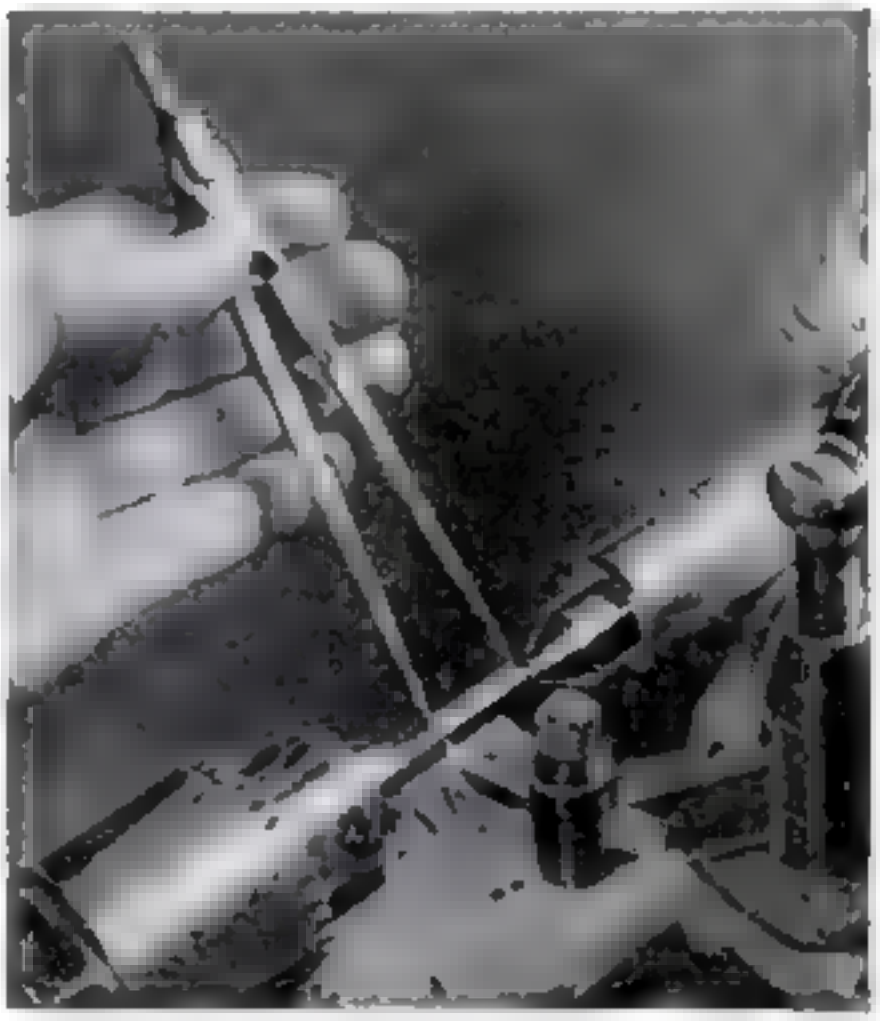
Length of Shaft Increased by Cutting and Welding

INSTEAD of welding in an extra piece to lengthen a shaft that is short by only a fraction of an inch, cut it at an angle as below. Rotate one part to bring the longer sides together. The open joint thus formed is ideal for welding.—WILLIAM SWAN.



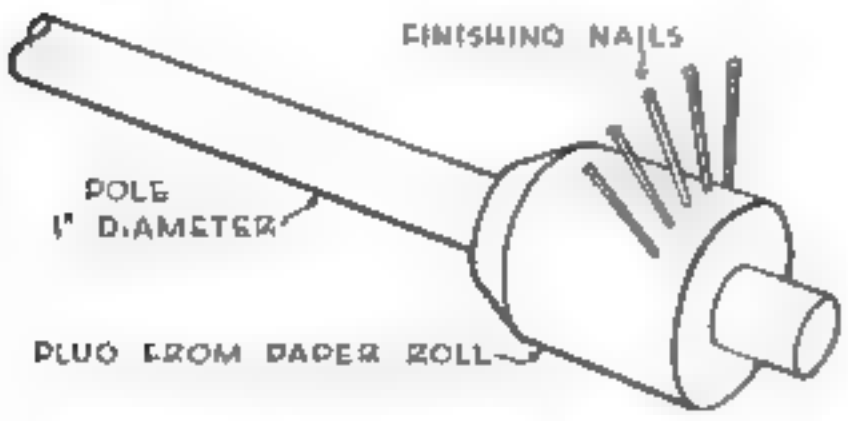
Delicate Lathe Work Gauged with Drawing Instruments

DRAFTING dividers and rules are useful for gauging small precision parts. They may be used for both internal and external measuring, and are convenient for laying out faceplate work.—H. R. H.



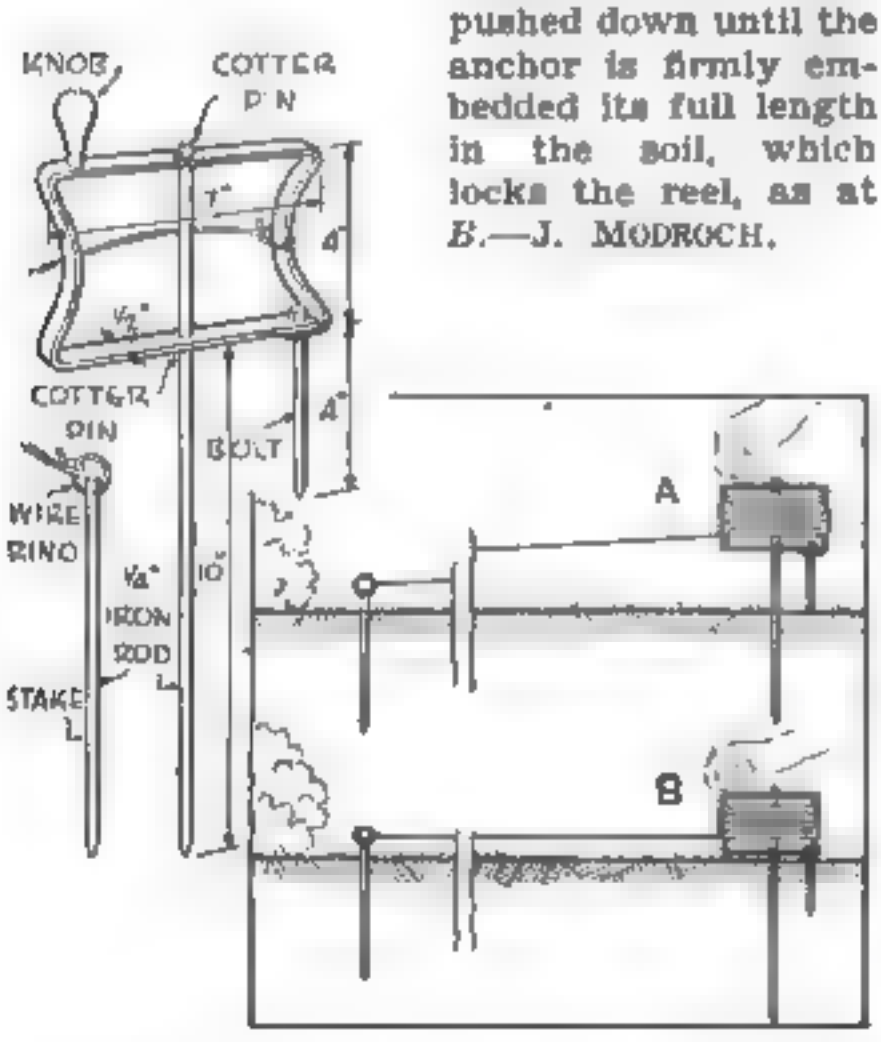
Drafting instruments are convenient for laying out and measuring small parts accurately in the lathe

Garden Hints

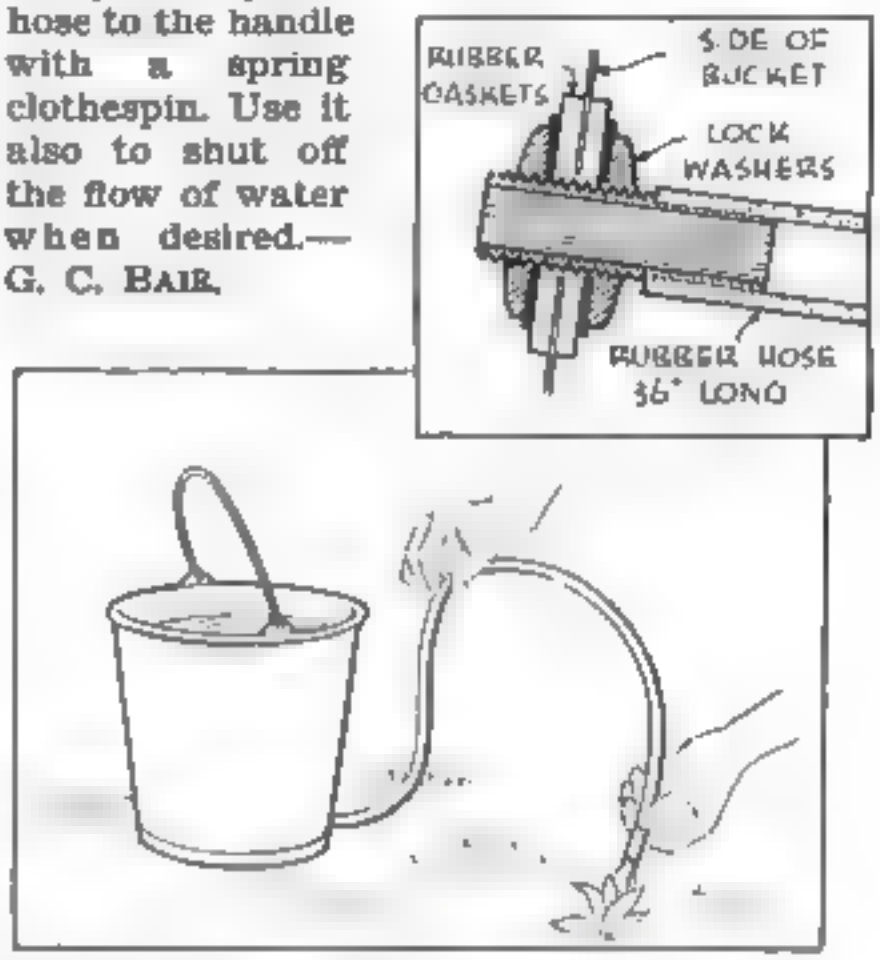


A PICKER for out-of-reach cherries can be made in a few minutes. Insert one end of a long pole about 1" in diameter into the wooden plug from a roll of wrapping paper. A local store will usually furnish such a plug for the asking. Drive four or five finishing nails part way into the plug to serve as teeth.—DONALD C. MCMILLAN.

THIS REEL will hold the garden line taut at any desired length. Bend it to shape from ⅛" strap iron, and clinch the ends under a nut threaded on the bolt that serves as the anchor. Mount upon the shaft, attach a knob or spool for the handle, and finish with aluminum paint. In use, the shaft is driven partially into the ground and the line paid out and fastened at the end, as at *A*. The slack is then reeled in and the shaft pushed down until the anchor is firmly embedded its full length in the soil, which locks the reel, as at *B*.—J. MODROCH.

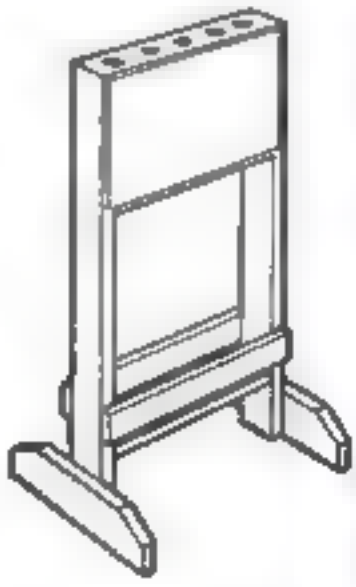


FOR TRANSPLANTING, applying vitamin B_1, or watering roses without wetting the leaves, the gardener will find this irrigation bucket convenient. A 36" length of shower hose is connected to it by means of a ¼" pipe nipple as shown. Water can be supplied exactly where needed, or left to flow without further attention. When necessary to carry the pail, clip the hose to the handle with a spring clothespin. Use it also to shut off the flow of water when desired.—G. C. BAIR.



Delicate seedlings can be watered safely by pinching the tube to control the rate of flow

ROLLING GARDEN-TOOL HOLDER. This can be made from an old rack of the type used by storekeepers to display brooms. Four wheels from a discarded baby buggy are attached by nailing the axles fast to the wooden crosspieces, as at the right.—J. C. MURPHY.



ALL-BALSA PLANE MODEL

...The Minute Man

By
FRANK ZAIC

Editor of the "Model Aeronautics Year Book"

All materials for this trim little ship cost less than half a dollar

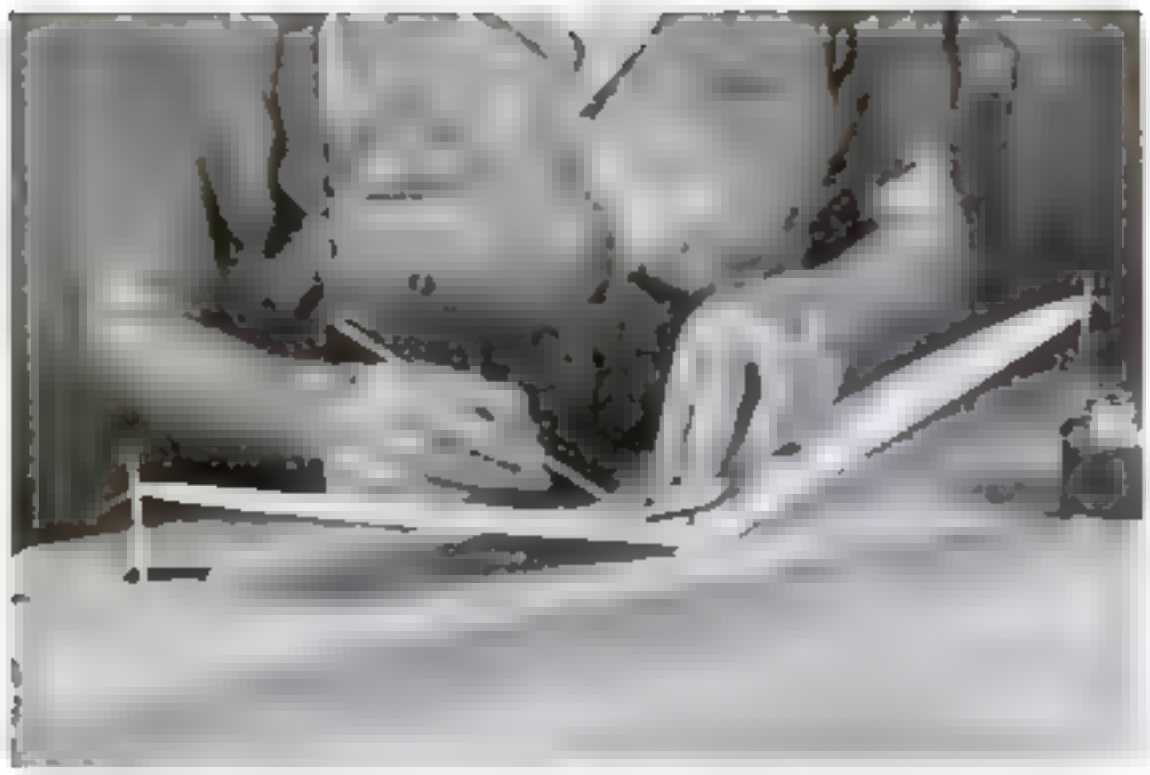
THIS little plane, capable of flights of over 2,000 feet, can be built and launched in less time than is usually required to construct the fuselage of more complicated models. Its sturdy, simple design is an instructive example of what can be done with lightweight and quarter-grained ("C" cut) balsa sheets (see P.S.M., Dec. '40, p. 198).

In selecting the balsa, see that it is light and shows the speckled surface which identifies "C" grain. Cut the fuselage and wing parts cleanly with a sharp blade to produce smooth edges. The dimensions of the fuselage cross braces should be taken from the numbered scale which appears in the drawings. Notice, in the detail of the nose, how the eight braces are offset for maximum strength. Spread cement carefully along the full length of the edges when assembling the fuselage. The top and bottom sheets are trimmed flush with the sides after the cement has hardened.

The wing camber is obtained by moistening the under surface with water, and allowing the single end rib to extend the camber along each wing. The sheet may at first tend to curve upward, but will assume the proper downward curve as it dries. When it is quite dry, apply broad streaks of cement to the underside, as shown in the drawings. These are important.

Cut the propeller blank from a straight-grained block of balsa, ⅞" by 1⅛" by 8". Because no model plane is better than its propeller, the builder is urged to read the instructions given in the article following this one.

The freewheeling device shown in the plans operates in this way: The long hook is so fastened to the propeller that it normally springs out of contact with the triangular hook on the motor shaft. After the rubber is wound, the hooks are engaged by hand. When the motor has been exhausted in flight, the propeller overruns the shaft, and the long hook springs free, permitting the propeller to turn upon the shaft. It is



Form the dihedral angle by elevating wing tips three inches above the center, and cement on the overlapping strip and fairing block

Propeller, detachable nose block, "freewheeler," and rubber motor. The hook on the propeller engages the shaft while motor is under tension, springing free when the energy of the rubber is exhausted

LIST OF MATERIALS

2 pc "C" cut balsa 1/32" by 2" by 36" for fuselage
1 pc. "C" cut balsa 1/20" by 3" by 36" for wing and tail
2 pc. hard balsa 1/16" square by 36" for fuselage braces
1 pc. balsa ⅜" by 1⅛" by 8" for propeller
1 pc. balsa ¼" by 1" by 2" for nose block and fairing block
1 pc. 0.034" piano wire, 24" long, for landing gear
1 pc. 0.020" piano wire, 3" long, for freewheeler
8′ rubber strand, ⅛" flat (brown); 1 pair hardwood wheels, 1" diameter; 4 washers, 3/16"; 2 shaft bushings, ½" long; cement, celluloid, bamboo, rubber bands.
Estimated cost: about 35 cents

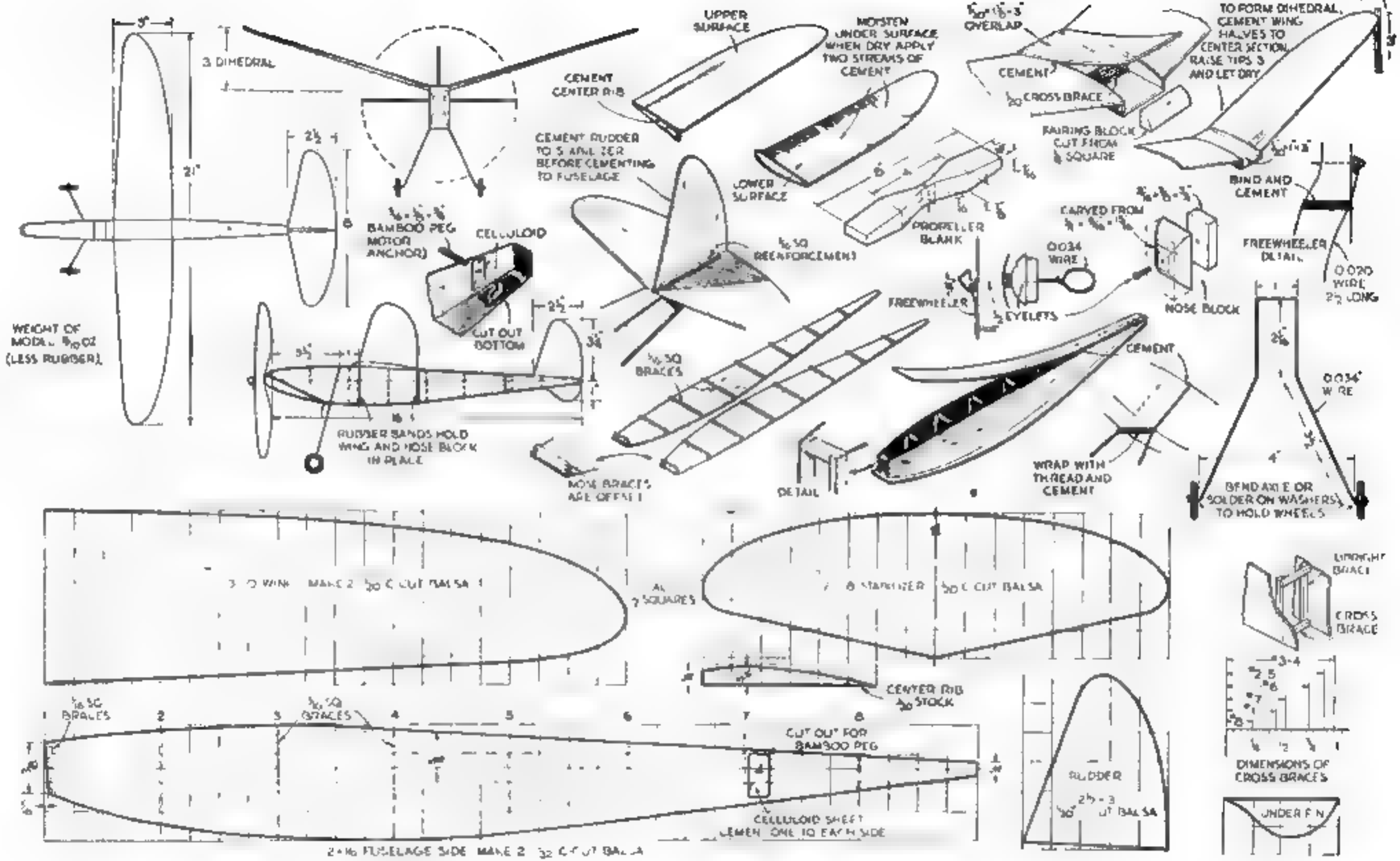
important that there be no friction between propeller and shaft once the hooks are disengaged. A drag at this point may cause the propeller to act as a rudder during the glide, spoiling the model's performance. In the case of a small ship such as this, a dragging propeller may even cause it to spin down in a spiral dive when the rubber is exhausted.

The motor consists of six strands of ⅛" flat rubber. Form it by winding the rubber over two nails placed 15" apart. Wet the ends, and tie with several knots. Lubricate the motor with glycerin before pulling it through the fuselage.

The nose block is made of two parts cemented together, its upper face being grooved for the rubber band which holds it to the fuselage. An eyelet is used for the shaft bearing. The fuselage shape shown will give the nose block an offset or down thrust of 1/16". After test flights have been made, or when the motor is to be wound up for maximum duration (700 turns), the nose block should be given about 1/16" right thrust. Only experiment will determine exactly the correct amount.

Before flying it under power, test the model's glide. Move the wing back if the ship stalls, or forward if it tends to dive. The rudder may be warped if a circular flight is desired. After a smooth, flat glide is obtained, make a test flight with the motor partly wound, and correct the wing setting if necessary. Once the adjustments have been made, the ship should readily make flights of more than a minute's duration in calm air.

Simplicity and sturdiness are the keynotes of this all-balsa design. Study the plans before starting work


3" DIHEDRAL
21"
WEIGHT OF MODEL 1/10 OZ (LESS RUBBER)
BAMBOO PEG MOTOR ANCHOR
CELLULOID
CUT OUT BOTTOM
RUBBER BANDS HOLD WING AND NOSE BLOCK IN PLACE
CEMENT CENTER RIB
UPPER SURFACE
MOISTEN UNDER SURFACE WHEN DRY APPLY TWO STREAMS OF CEMENT
LOWER SURFACE
CEMENT RUDDER TO STABILIZER BEFORE CEMENTING TO FUSELAGE
1/16 SQ REINFORCEMENT
1/16 SQ BRACES
NOSE BRACES ARE OFFSET
PROPELLER BLANK
FREEWHEELER
0034 WIRE
EYELETS
CARVED FROM
NOSE BLOCK
CEMENT
WRAP WITH THREAD AND CEMENT
DETAIL
1/20 CROSS BRACE
PAIRING BLOCK CUT FROM 1/8 SQUARE
TO FORM DIHEDRAL, CEMENT WING HALVES TO CENTER SECTION, RAISE TIPS 3 AND LET DRY
PIN
BIND AND CEMENT
FREEWHEELER DETAIL
0020 WIRE 2½ LONG
0034" WIRE
BEND AXLE OR SOLDER ON WASHERS TO HOLD WHEELS
WING MAKE 2 1/20 C CUT BALSA
STABILIZER 1/20 C CUT BALSA
CENTER RIB 1/20 STOCK
CUT OUT FOR BAMBOO PEG
CELLULOID SHEET CEMENT ONE TO EACH SIDE
FUSELAGE SIDE MAKE 2 1/32 C CUT BALSA
RUDDER 1/20 C CUT BALSA
UPRIGHT BRACE
CROSS BRACE
DIMENSIONS OF CROSS BRACES
UNDER FIN

The Trick of
Carving Good Propellers

Blank marked for cutting to proportions shown in the drawings. The shaft hole must be drilled true before any carving is begun

The under camber of each blade is first carved perfectly flat, then undercut and sandpapered to a concave surface. Below, testing the propeller for balance after blades have been trimmed to shape. Sand the upper camber to produce a true airfoil section

MODEL airplane meets are often won or lost by propellers. No matter how excellent the remainder of a model may be, a poor propeller dooms it to mediocre performance. To obtain maximum results from a rubber-powered model, the "prop" must be hand carved and of the proper design to convert efficiently the power of the motor into flight.

If you have been disappointed in your models, look to the propellers. The machine-cut or semifinished type usually is of too high a pitch, has insufficient blade area, and may be too thin to permit of shaping good airfoil sections. A beginner's very first hand-carved propeller may prove superior to the manufactured type.

Follow the instructions step by step. Do not try to hurry. Be sure your knife is sharp, and the balsa block straight grained and without knots.

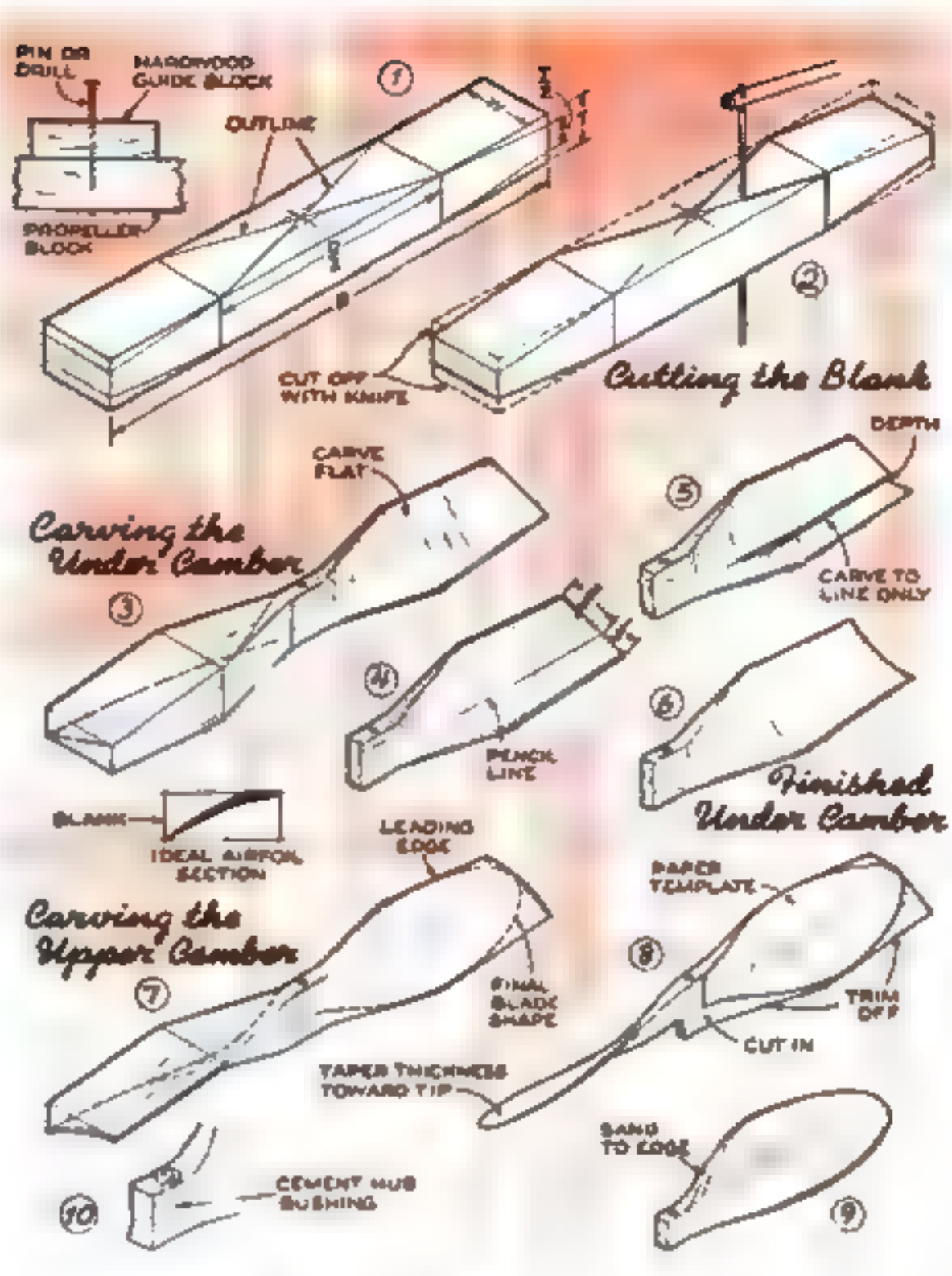
Outline the propeller blank on the block to the dimensions given in the plans of the model in hand. Locate and pierce the shaft hole, using a drill press or a guide block of hardwood in which a true hole has been drilled. Saw out the blank exactly to the lines. The portion back of the hub may be cut out now or after carving, if plans call for a narrowed hub.

Begin by carving the under camber perfectly flat, making no attempt to form a concave surface at this time. Draw a line along this flat blade, one third of its width from the leading edge, and make a light cut along this line. Carve the narrower portion of the blade downward toward the cut. The depth of this undercutting is often shown upon the plans. It

should be equal on both blades before the wider portions are carved down to complete the camber. The curve formed may be checked by sighting against a ruler laid across the blade and run from tip to hub.

Compare the two blades carefully. Rough spots are then removed by sanding lightly with 2/0 sandpaper. Meanwhile check the camber occasionally. Finish the surfaces with 6/0 or 10/0 sandpaper. This completes the work on the undersides.

In carving the upper camber, avoid heavy cuts. Note the gradual taper toward the trailing edge and the thicker, rounded leading edge in the airfoil section shown. The thickness may be judged by holding the blade against the light. Bright areas indicate thin spots, which should not be touched until the surrounding surface has been carved down. The blade thickness of propellers varies greatly according to the use for which they are intended, but should always taper toward the tips, the latter usually being sanded extremely thin.



Hubs of large propellers may be shaped when the blank is sawed out. Final hub thickness should be one half that of the propeller block

Finish shaping the upper camber with 2/0 sandpaper. Test the balance by inserting a wire through the shaft hole. If one blade is very much heavier, examine it and sand down excessively thick portions. Make a template of the blade shape to transfer it to one blade. Cut and sandpaper this to shape; then make a paper template of it for outlining the other blade. Trim to shape, but, before going further, balance the propeller and note the heavy side, which should be finished last.

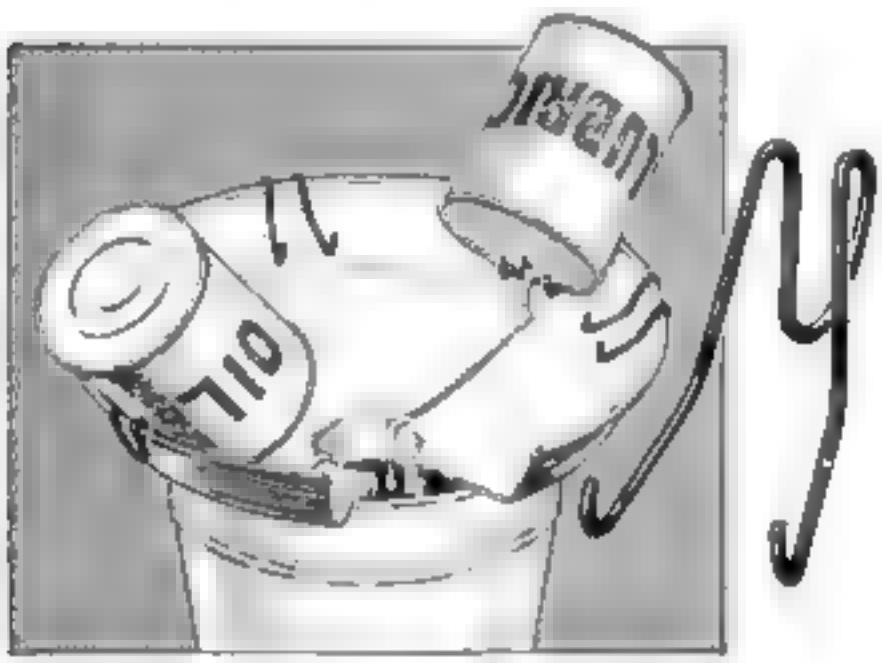
Now sandpaper the upper camber until a true airfoil section is obtained throughout the blade. The under camber should not be touched except at that portion nearest the hub. Check the balance continually while sanding. When both blades appear finished, check for thick portions and sand the upper camber of the heavier blade to balance. Occasionally one blade may be left slightly heavier to counterbalance a so-called "freewheeler" of the type attached to one side.

Several coats of cement that has been thinned slightly with clear dope should now be applied. This doubles the strength of the blades and provides a very smooth surface when properly polished. Brush on two coats and when dry rub down with No. 360A Carborundum paper, used wet. Apply two coats more and rub down again, then one or two final coats, sanding the last with No. 400A paper. Before waxing, cement the hub bushing and freewheeler or folding hinges in place.

All propellers for rubber-powered models should fold or freewheel, assuring a longer and more stable glide when the power is exhausted. Freewheeling devices should allow propellers to turn upon the shaft with minimum friction. The hinges, hooks, wires, or other parts of such devices, which are subjected to a considerable strain during the motor run, should be well fitted and firmly cemented and bound in place.

Drip Collector Recovers Oil Left in "Empty" Cans

A GARAGE owner in Akron, Ohio, recovers enough oil from quart cans, after their contents have been emptied into engines, to keep several small oilers filled for general lubricating use. Such containers always have a small quantity left in them, which can be drained off by means of a drip collector made from an old enameled lamp shade of the type known as an "RLM dome." This is placed funnel-like over a bucket, and several clips bent from stiff wire are hooked over the rim to hold the upturned cans. If a shade of this kind is not available, a large funnel such as is used in drain pits will do.—WALTER E. BURTON.



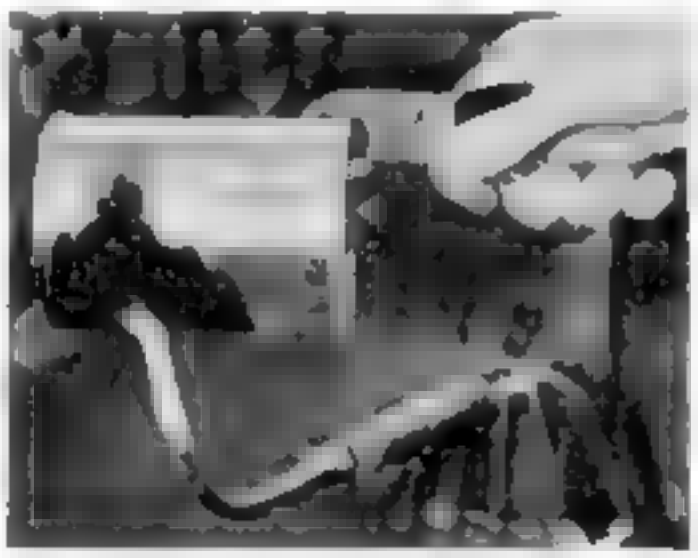
Bent Handle on Aquarium Net Helps in Removing Fish

ALMOST every one who owns an aquarium has sometimes torn up aquatic plants while trying to remove fish with a net. This can be avoided by making a 90-deg. downward bend about ¼" from the mouth of the net, and straightening the handle with another 90-deg. bend as shown. This makes it easy to trap a fish against the glass side, as the offset handle clears the upper frame of the tank.—S. P. WIENER.

Holes Punched in Light Sheet Metal with Aid of Strap Hinge

An ordinary strap hinge will serve as a die for punching small holes in thin copper, brass, or tin. The hinge pin should fit without play to keep the two leaves aligned

SMALL HOLES can be punched in lightweight sheet metal with the help of a common strap hinge. Bend one leaf of the hinge to close parallel with the other, and drill a hole of the required size through both. It may be necessary to bend the hinge pin to eliminate any play between the parts. Use either a pin punch or nail set ground to the size desired. When the holes in the hinge are worn too large to be of further service, it is a simple matter to drill new ones elsewhere.—E. A. BOWER.

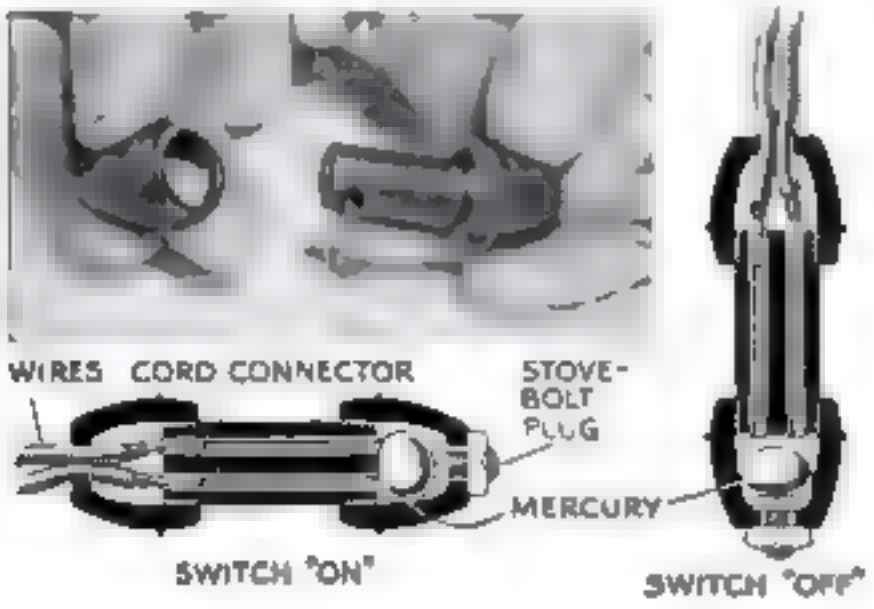


Lampblack and Alcohol Polish Reflectors

A PASTE of lampblack and alcohol is excellent for cleaning highly polished metal reflectors. If no lampblack is at hand, simply hold a tin can over a yellow-burning acetylene or natural-gas flame, and scrape off the deposit. Mix with alcohol and rub on gently. After cleaning, polish the reflectors with a soft cloth.—ROY ELTON.

Silent Mercury Switch Made from Auto-Cord Connector

A NOISELESS automatic switch that will turn on a light when a door or lid is opened, as for example in an automobile luggage compartment, a photo-printing box, or the like, can be made for a few cents. Plug one cap of an auto-cord connector with a stove bolt, pour in a small amount of mercury, and screw the cap fast, as shown below. Mount to close the circuit as desired.—B. N.

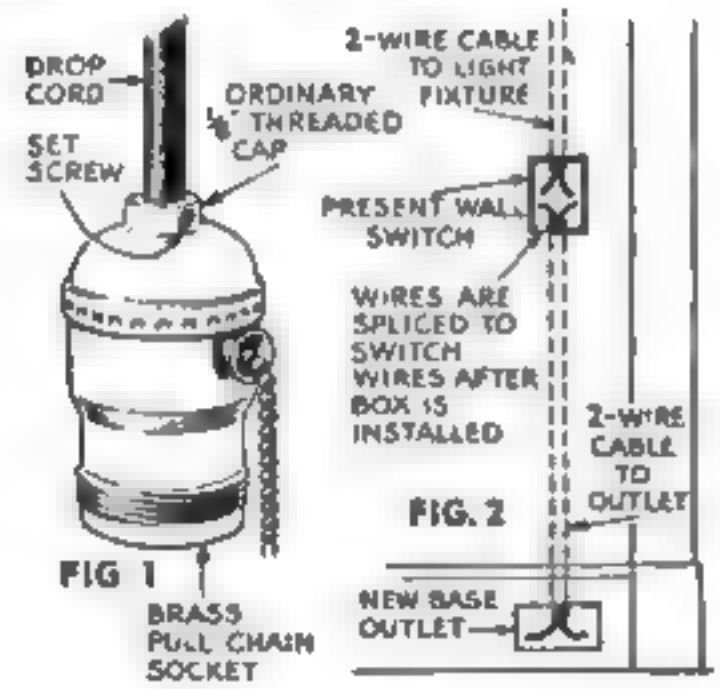


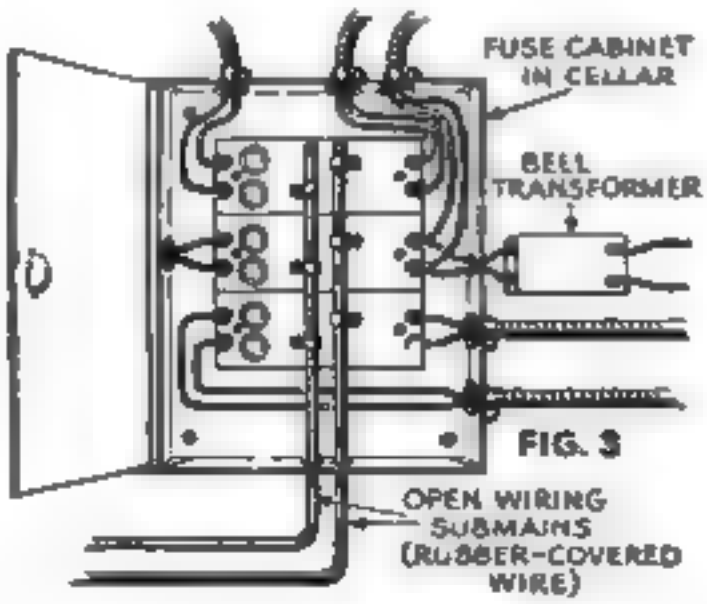
Replacing Worn-Out Contacts in Ornamental Push Buttons

IT IS often impossible to buy an exact duplicate of an ornamental push button that matches other house fittings. If the contacts of such a button are worn out, simply remove them, ream out the hole to fit a midget pearl push button rather tightly, and press the latter into place. In this way new contacts can be fitted as often as necessary. The decorative shell will, of course, last indefinitely.—H. P. S.

CAN YOU FIND NINE *Electrical Errors?*

Two electrical errors are shown in Fig. 1, one in Fig. 2, and six in Fig. 3. Can you find them? The answers are given below.





1. A brass pull socket should never be attached to a drop cord through an ordinary threaded cap. A cap with an insulating bushing must be used. The threads for the shade holder at lower end of socket, shown at left-hand, are always right-hand threads.

2. A base or convenience outlet cannot be connected to a switch unless both the live and grounded sides of the line happen to be available in the switch box. Usually there is only a cut loop of the live side.

3 (a) Porcelain bushings must be used where open submains enter a box. The use of conduit is preferable with a metal cabinet.

(b) Transformer leads also should enter the cabinet through porcelain bushings, or through a pipe nipple if the transformer is mounted in a separate metal box.

(c) When more than four circuits or eight conductors are to be connected to a cabinet, it must have back wiring spaces or side spaces, or it must be of the gutter type.

(d) Transformer wires must not be connected under circuit terminal screws.

(e) Fuses missing on right side of cut-outs.

(f) Double fusing shown on left side of cut-outs not in accordance with present practice.

Home-Laboratory Experiments Show

How the Body Works

ONLY RECENTLY has a camera been perfected that will adapt itself to light conditions with a self-adjusting iris diaphragm, as the human eye has always done. The eye's amazing power of automatic focusing still defies imitation. Science has yet to duplicate marvels of mechanics and chemistry that the human body constantly performs. But the simple experiments described on these pages will help to satisfy a person's curiosity about what makes him tick. The final experiment shows how nature, in an emergency, allows a subordinate to act without consulting its superior, the brain.

Iris diaphragm of these eyes has closed down, in bright light . . .

whereas now the light is feebler, and the diaphragm has opened up

Your Own Eyes Act as a Light Meter

PHOTOGRAPHIC instrument makers were far from the first to conceive a device that would register and adjust itself to light changes. In the human eye, as in those of many animals, nerves cause the iris diaphragm to close down as light increases, and open up as it dims. So accurate is this response that a new exposure meter provides a mirror in which the user can gauge the diameter of the pupil of his eye to get the right exposure.

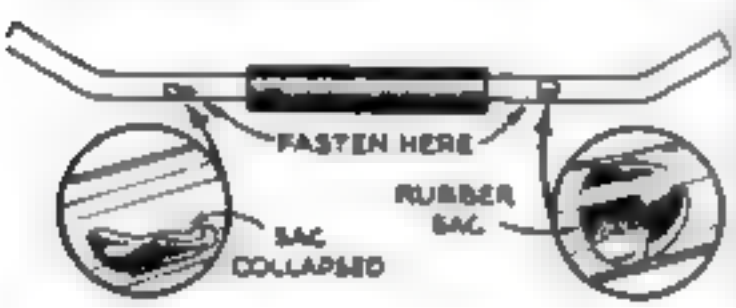
How Swallowing Affects the Human Eardrum

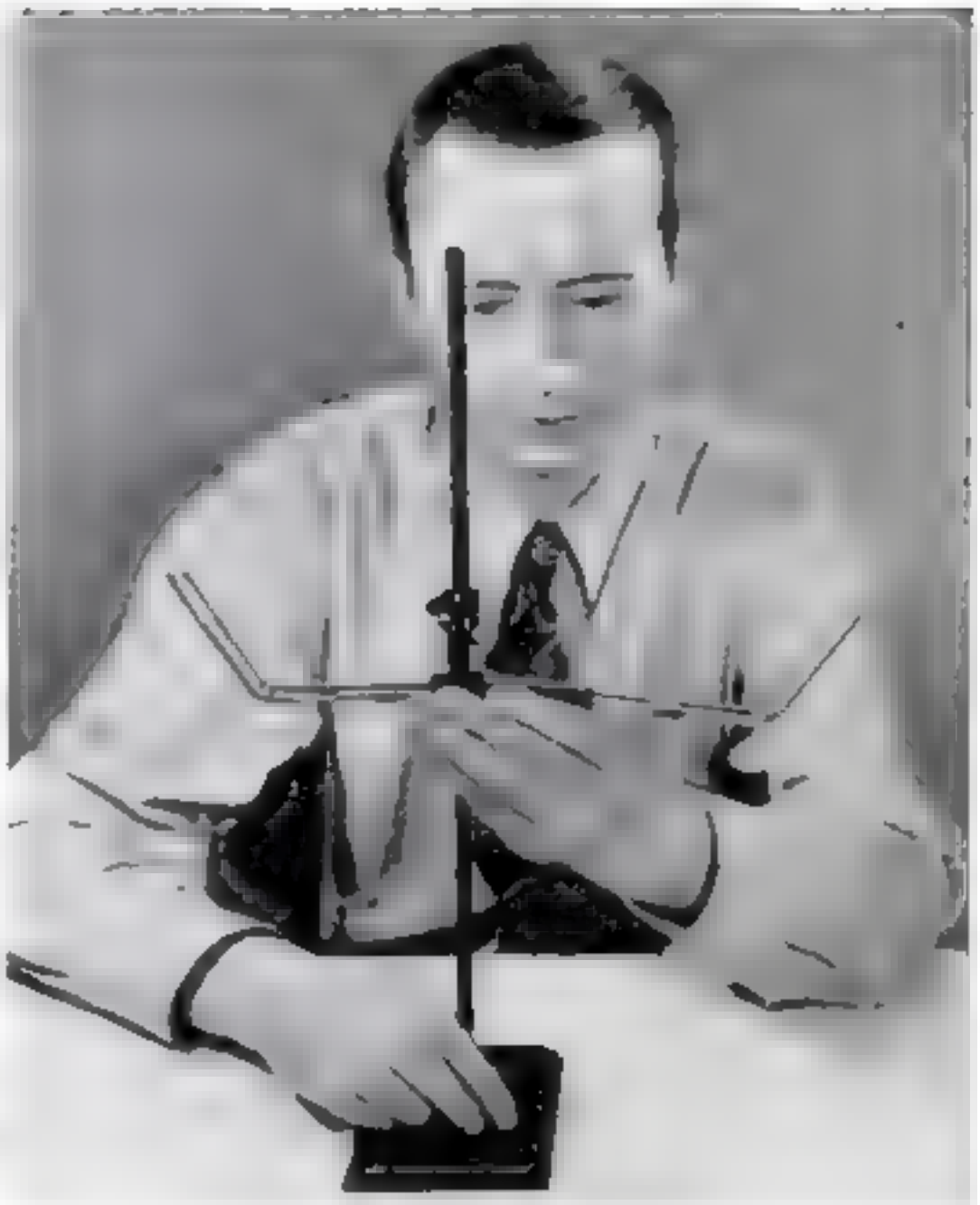
BLOW into the tube of the set-up illustrated, and a partial vacuum will draw the rubber membrane inward. Similarly, if a man holds his nose and swallows sharply, he will feel his eardrums snap inward. They will spring back when the nose is released, if the Eustachian tubes connecting them with the nose and throat are clear. Divers and sandhogs do this before going under compressed air.

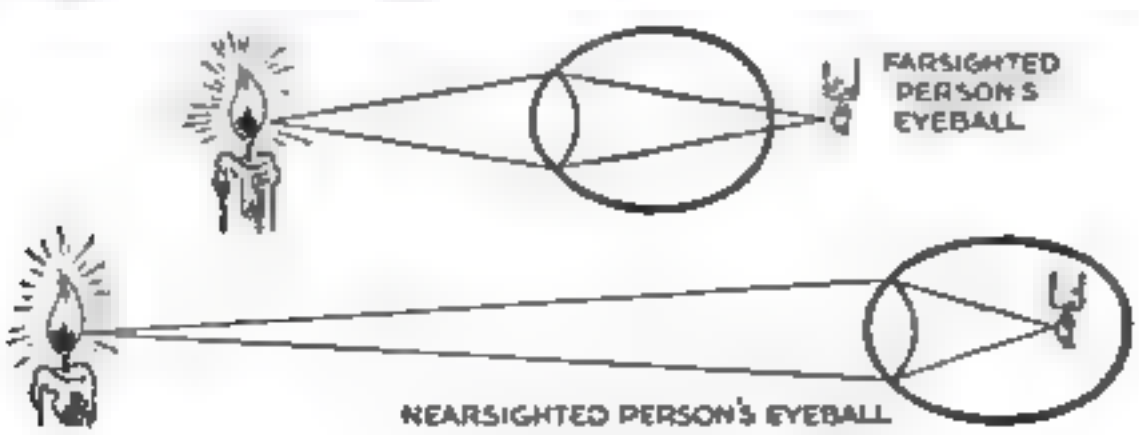
Apparatus illustrates the effect of air pressure on eardrum

Valves in Veins Help To Keep Blood Moving

AFTER PASSING through the arteries and minute capillaries, blood has lost much pressure. Squeezing movements of muscles around the veins, and tiny one-way valves within them, help boost blood back to the heart. To show this, cut two sacs of rubber from a toy balloon, and cement one edge of each to the inside of a bent glass tube. Connect the glass tubes with rubber tubing. Pour water into the right-hand tube, in the diagram, and it will rise to equal height at left. Squeeze the rubber tubing, and the water will flow only to the left, because of the valve action.







How the Eye Focuses To Picture Distant and Near-By Objects

A MAGNIFYING GLASS and a candle will demonstrate the principle of focusing, which the eye performs automatically. The nearer an object, the farther a lens must be from a screen to make the image clear. Consequently, muscles of the eye focus an image on the retina by lengthening the eyeball for near objects and by shortening it for far ones. Some people have abnormally short eyeballs, which make them farsighted. They cannot bring near objects into focus, since the image is formed behind the retina. Others, with long eyeballs, are nearsighted and cannot focus on far objects because the image forms before the retina.

Dilating Diaphragm Pulls Air Into Lungs

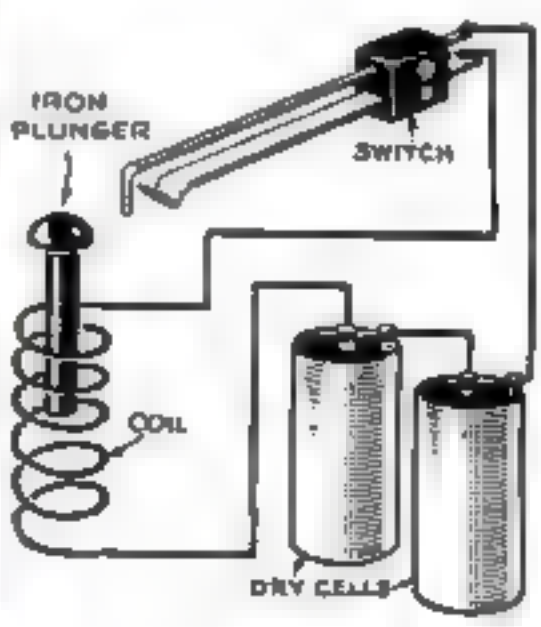
TOY BALLOONS, the top of a glass coffee maker, and glass tubing will demonstrate how, distending the diaphragm draws air into the lungs. Glass tubes from each balloon pass through a stopper in the neck of the coffee maker. Adhesive tape holds a rubber diaphragm over the large end. Normally the balloons hang limp, since air pressure inside and out is equal. But when the diaphragm is pulled down, producing a partial vacuum, air drawn in from the outside expands the balloons.

Getting Food from Blood to Tissues

TO REACH the tissues from the digestive organs, dissolved food travels via the blood stream. To show how it gets in and out, insert a glass tube in the small end of an egg, sealing it with wax. At the egg's large end, break away enough shell to cover a penny, without damaging the lining membrane. Stand the egg in water, as at left. After several hours, water entering through the membrane will have forced the contents of the egg into the tube. The phenomenon is called osmosis.

Reflex Action Pulls Hand from Fire

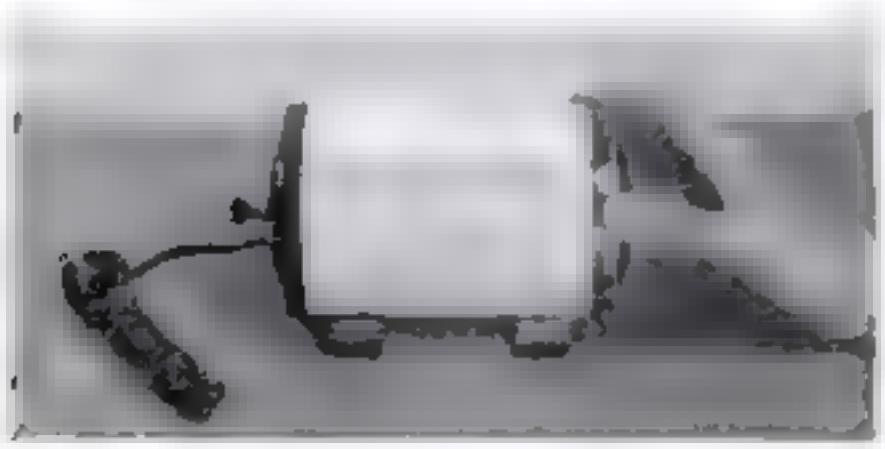
IF A FLAME burns your finger, a sort of short-circuit called a reflex takes place. Faced with an emergency that cannot wait for instructions from the brain, the spinal cord switches nerve impulses from the finger directly to muscles that jerk the hand away. A switch operated by expansion of copper with heat will actuate a homemade electric model of a similar "reflex."



Radio Ideas

Illuminated Calendar Lists Week's Radio Programs

TO REMIND you when your favorite radio programs will be on the air, a rotating, internally-illuminated calendar is now available. Shown below, it is made of frosted glass with metal trim, and has spaces for listing programs for each day of the week.



"Floating" Needle Filters Scratching from Records

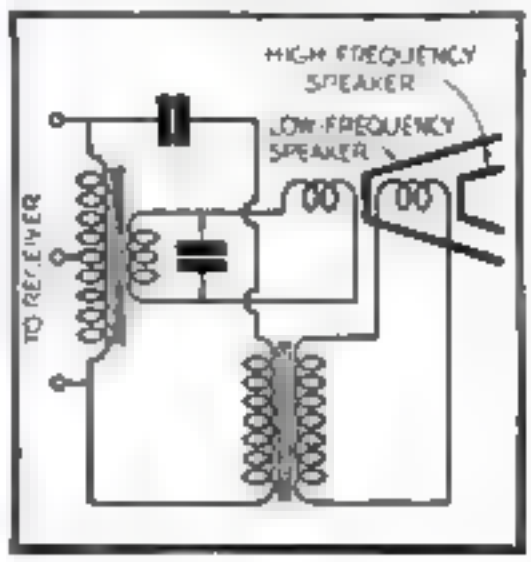
THE SCRATCHING of a needle against a record, which so often spoils otherwise good phonograph reproduction, can be eliminated by using a new long-life needle that stops the scratch noises right where they start—in the needle. A point made of an alloy of ruthenium, osmium, iridium and rhodium (precious metals of the platinum group) is mounted in a shank that allows the point a "floating" motion. This sets up a vibratory movement and filters out the minute scratch frequencies without interfering with the recorded tones. This shank also protects the point from damage.

Phonograph Arm Provides Adjustable Needle Pressure

ANOTHER STEP toward better phonograph reproduction is this pick-up, which has a frequency range of 40 to 6,000 cycles, and on which the needle pressure can be adjusted from one to three ounces. This is accomplished with a sliding weight similar to that used on some types of scales. A calibrated scale on the pick-up shows the pressure exerted by the weight in various positions. All moving joints in the unit are fitted with ball bearings.

Loudspeaker Within a Loudspeaker Is Used for FM

Diagram shows hook-up of double loudspeaker used in high-fidelity reproduction



A LOUDSPEAKER within a loudspeaker is now manufactured for use with high-fidelity equipment such as is found in frequency-modulation and television receivers. A small permanent-magnet speaker mounted in the center of a 15-inch diaphragm reproduces frequencies above 2,000 cycles, the larger one the low notes. With a proper amplifier, this outfit can reproduce frequencies of 50 to 12,000 cycles.

You can "broadcast" a record directly from the suitcase phonograph to any portable radio

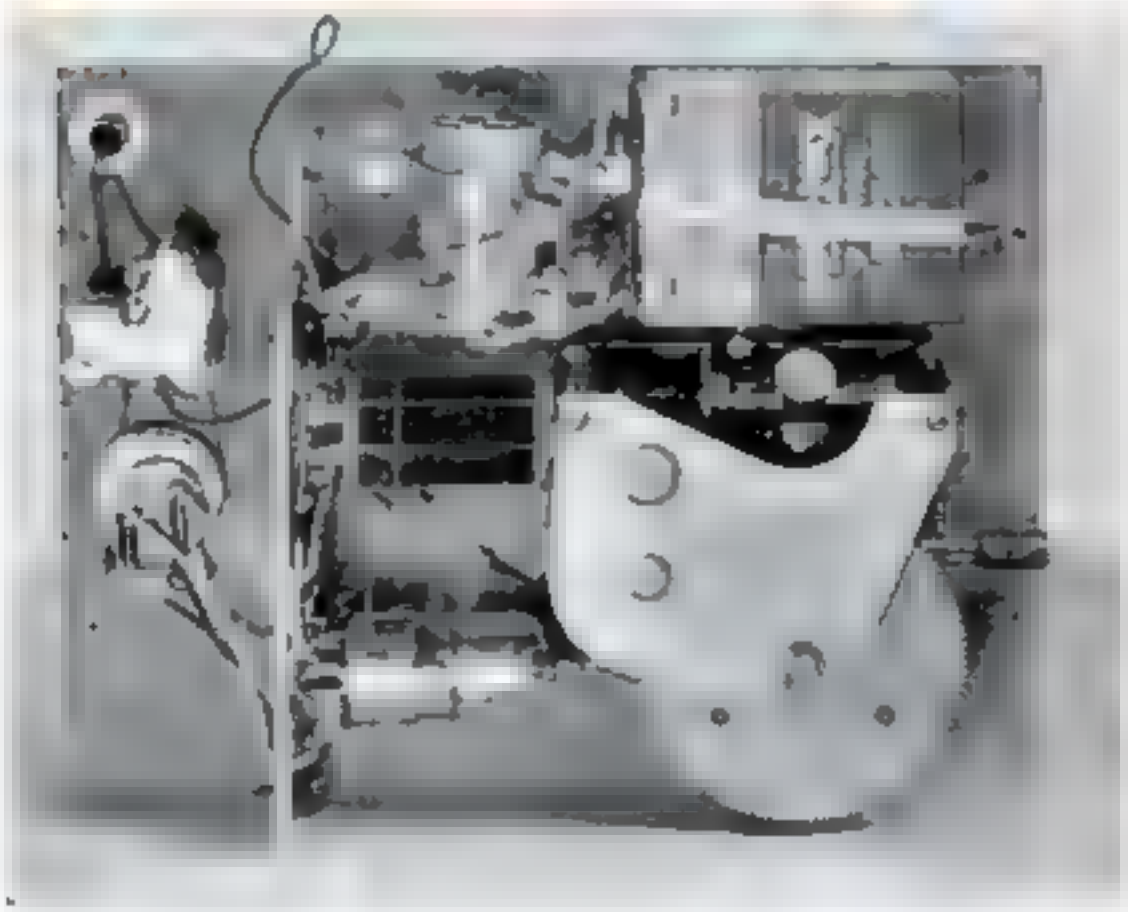
Suitcase Phonograph for Portable Receivers

By ARTHUR C. MILLER

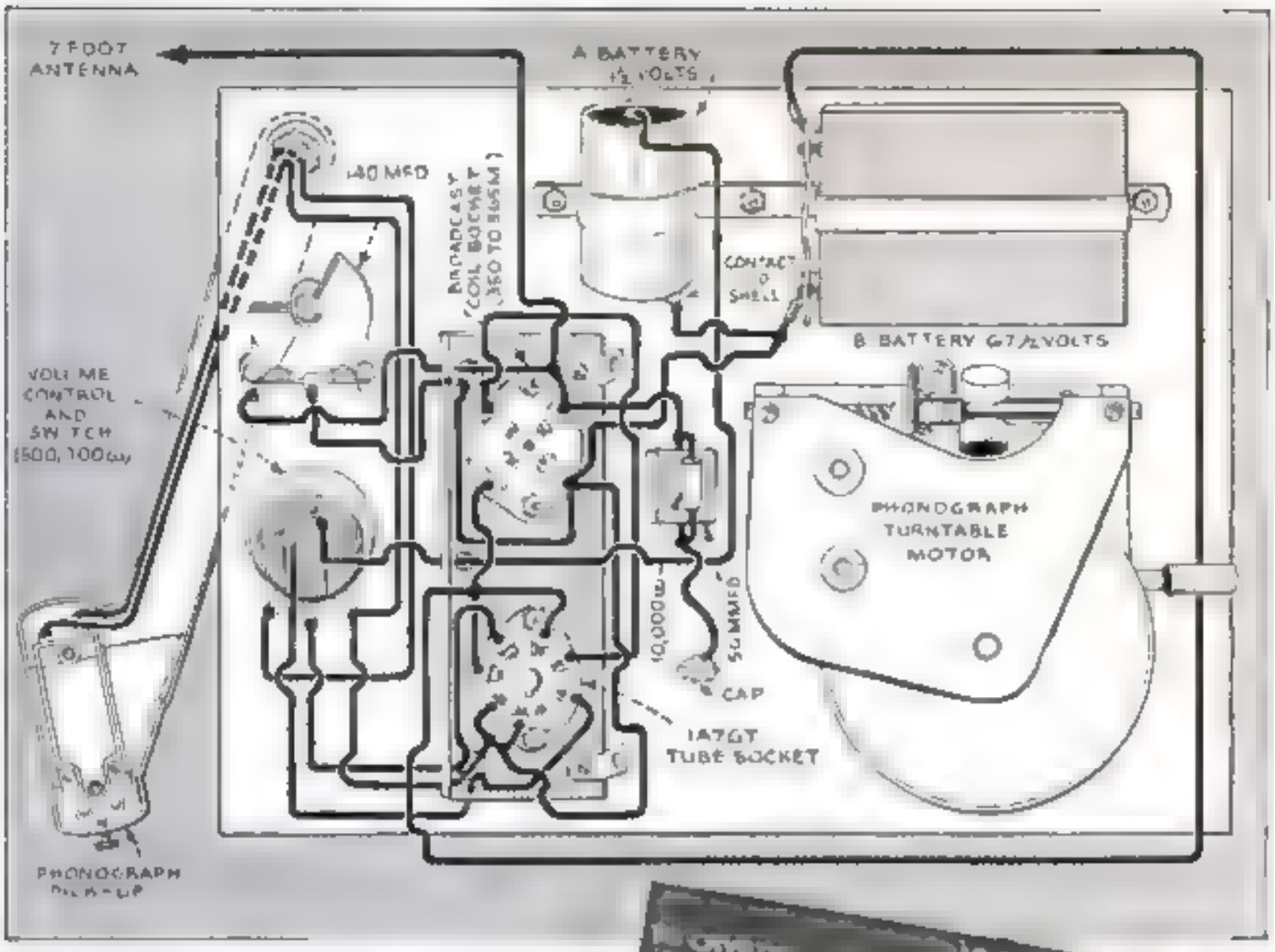
THIS SUMMER there will be thousands of battery-operated portable radios in use on beaches, in parks, and on picnics and excursions everywhere. They will range from the camera-style midget or "personal" radios to the "twenty-pounders," capable of bringing in Europe on the short-wave band.

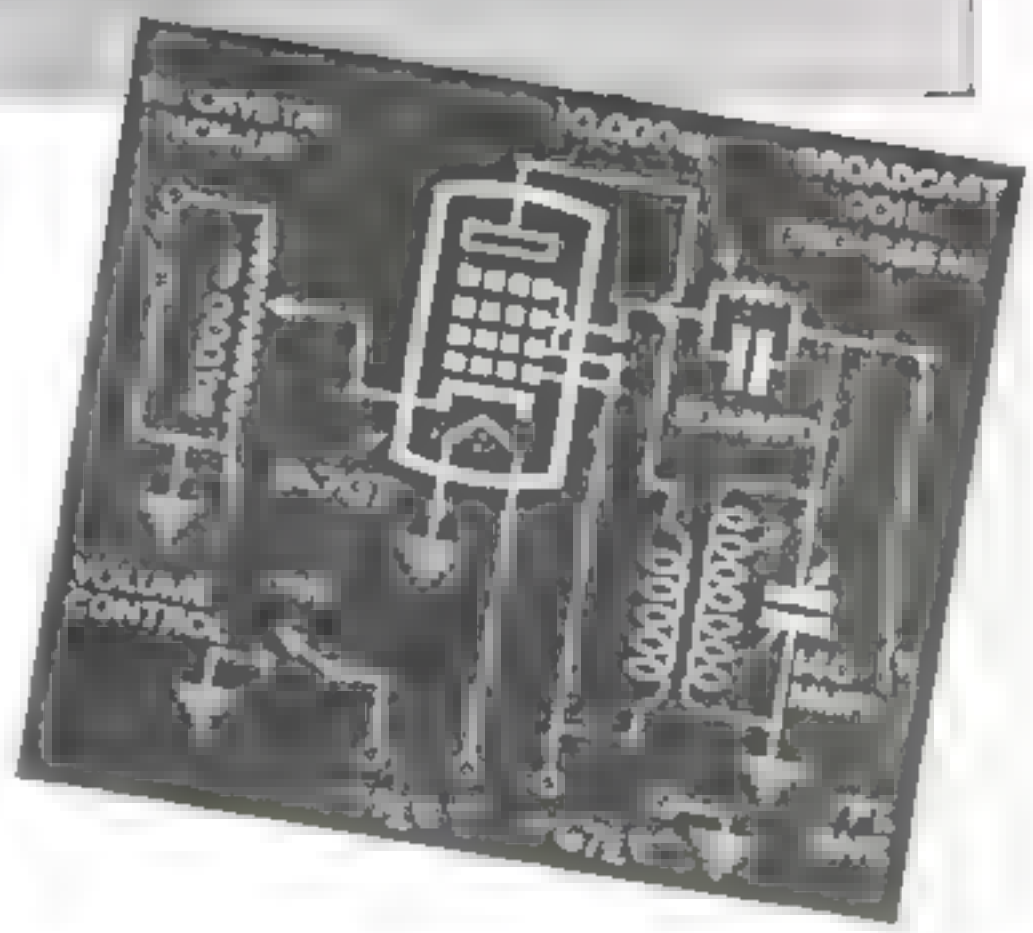
This battery-operated "wireless" phonograph was designed for use with these portable sets. As the name implies, the unit will transmit recorded sounds to the portable, through the medium of radio waves. The radio in turn reproduces them through the loud-speaker. No connections between the phonograph and the portable are necessary.

This combination of radio and phonograph will enable you to fill the interludes between radio programs that appeal to you with recorded dance music, symphonies, or whatever you wish. The volume control will



Underside of the phonograph's Masonite baseboard, showing transmitter, batteries, and turntable motor





Above, sketch of the set-up of the suitcase "wireless" phonograph, as shown in photo on previous page. At right is wiring diagram

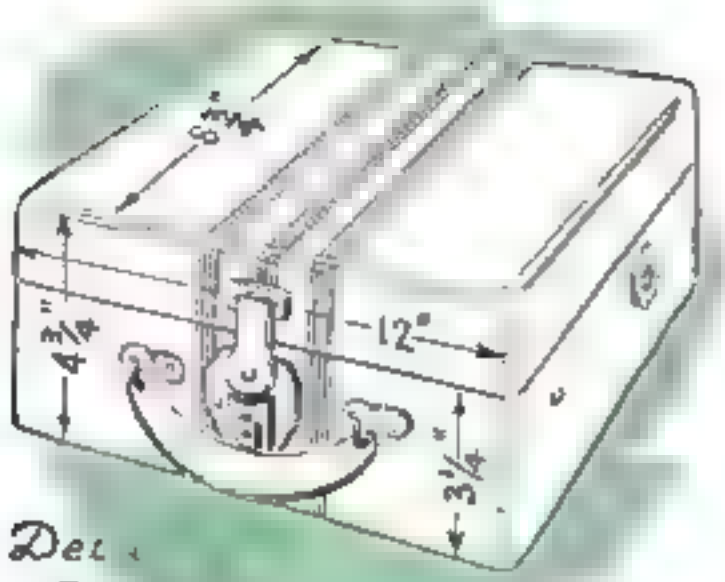
make it possible to lower the sound of your music so that it will not disturb your neighbors, or turn it up to fill a room with music for dancing.

Being light and compact (12 by 8¾ by 4¾ inches) the phonograph can be carried along as easily as a small suitcase. It is entirely self-contained and self-powered. Two small batteries (similar to those used in the personal-type radios—a 1½-volt flash-light cell and a 67½-volt "B" battery) supply all the current necessary to operate the transmitter. The power of this transmitter is so small that it will not radiate signals beyond a few feet. It is the only type of transmitter that can be operated without a license under Federal Communications Commission regulations.

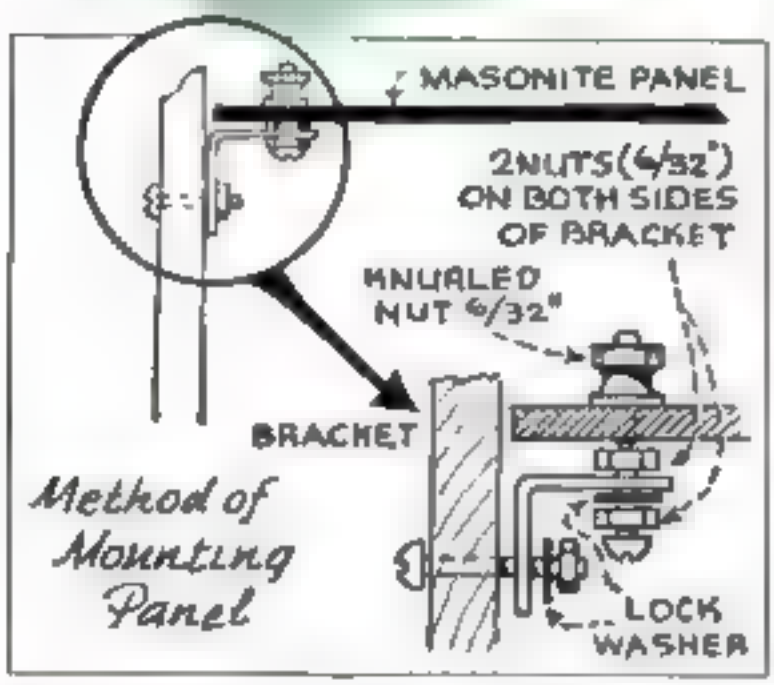
The transmitter uses a 1A7GT converter tube which acts as a combined modulation and radio-frequency amplifier. The electric impulses from the phonograph pick-up are modulated by the first and second grids of the tube. In a 1A7GT, or similar tube, the second grid acts as a plate. The modulated signal is then superimposed on the carrier wave, generated by the second portion of the tube, and transmitted to the receiver, where it is amplified and transformed back into sound.

The transmitter is tuned by a .00014-mfd. (or 140-mmfd.) tuning condenser and a standard four-prong broadcast coil. To cut down costs, the four-prong socket for the coil and the eight-prong (or octal) socket for the tube are both wafer types, inverted so that they can be mounted on the Masonite baseboard and used instead of the more expensive molded socket.

The suitcase into which the phonograph is fitted can be purchased almost anywhere for

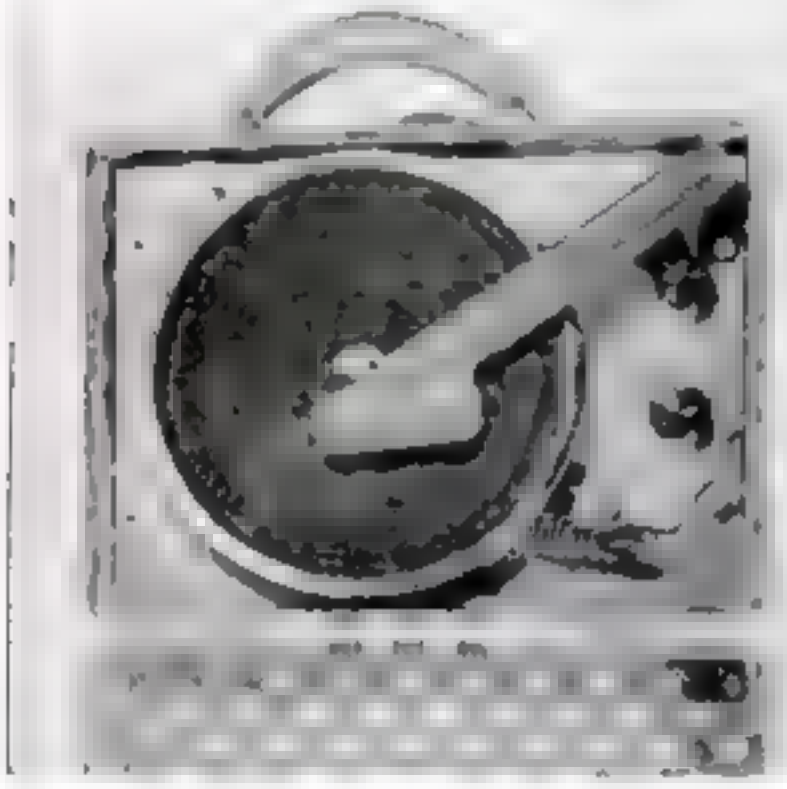


Detail of Suit



Method of Mounting Panel

Left, detail of the suitcase, and above, a stage of mounting, before installation of the turntable



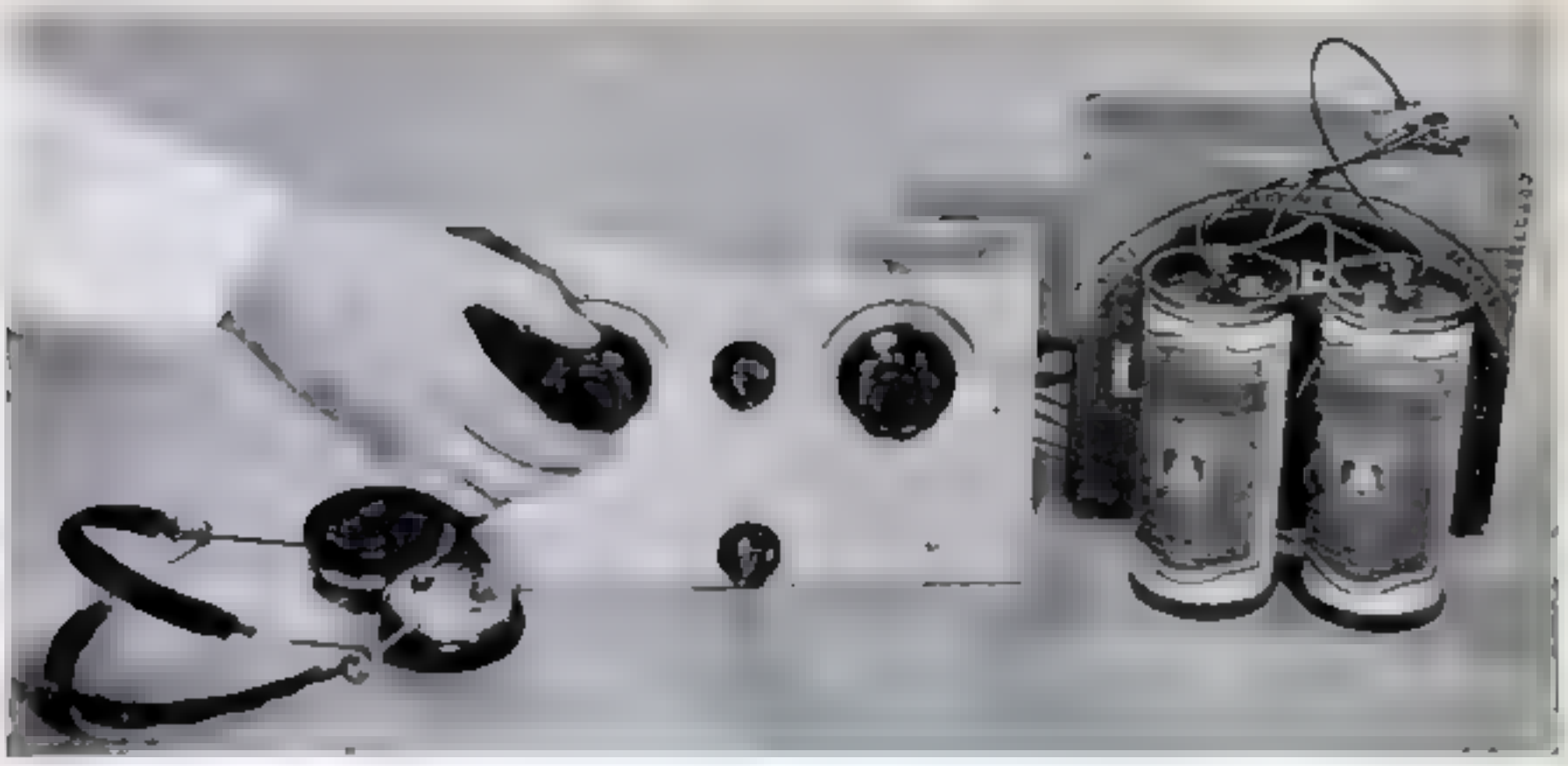
Completed phonograph seen from above, with eight-inch turntable. The seven-foot antenna is coiled

less than $1. A spring motor can be picked up secondhand for about $2.50, or it may be ordered direct from a manufacturer. An eight-inch or smaller turntable must be used, otherwise a larger suitcase than is shown in the accompanying illustrations will have to be purchased. A Masonite panel 11¼" by 8¼" is used for mounting the motor, pick-up, and transmitter parts. In the set shown here, the panel was left in its natural brown finish, since this blended with the brown-striped covering of the suitcase. The two batteries are strapped to the undersides of the panel with a flexible brass band ⅜-inch wide. This will keep them from knocking about in the bottom of the case, and they may easily be replaced whenever necessary.

To operate the phonograph, place the seven-foot antenna near the back of the portable receiver (where manufacturers usually place the loop antenna). Then turn the transmitter on by means of the switch on the 500,000-ohm volume control, and tune the unit to some free spot on the receiver's dial by rotating the 140 mmfd tuning condenser. Records can then be played on the phonograph, and will be heard over the set's loudspeaker.

LIST OF PARTS

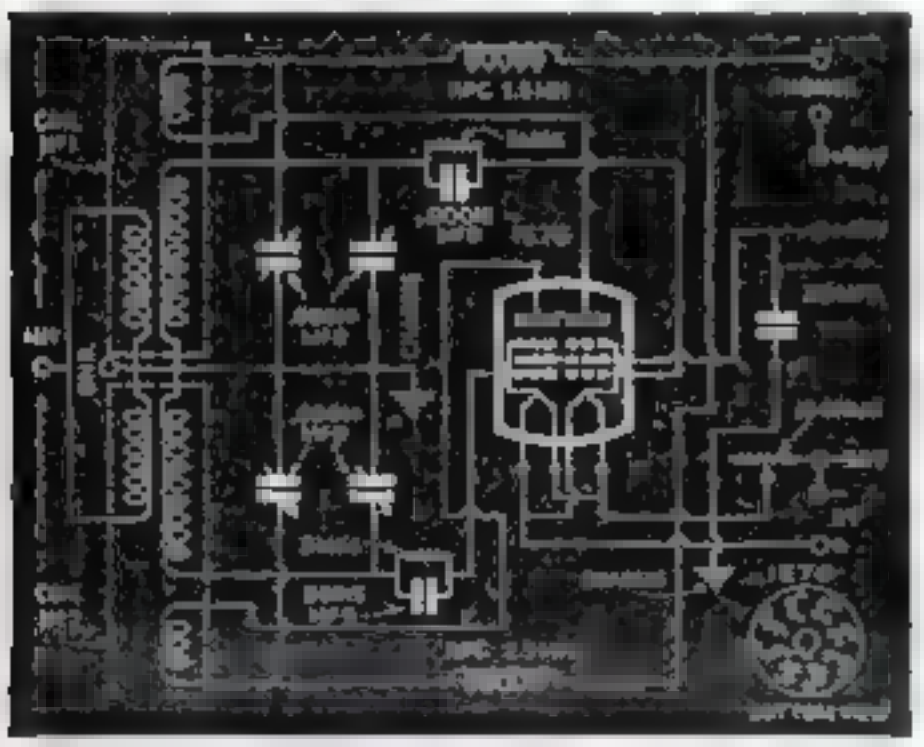
Converter tube, 1A7GT.
Volume control and S.P.S.T. switch, ½ megohm.
Crystal pick-up.
Four-prong broadcast coil, 850 to 565 meters.
Tuning condenser, 140 mmfd.
Octal and four-prong wafer sockets.
Carbon resistor, 10,000 ohms, ½ watt.
Mica condenser, 50 mmfd.
Seven-foot antenna.
Small, brown-striped suitcase.
Masonite panel, 11¼" by 8¼".
Midget "B" battery, 67½ volts.
Standard flashlight cell, 1½ volts.
Spring-wound motor with 8" turntable.



Anything from short waves to the long-wave aircraft beam signals can be tuned in on this one-tube set

One-Tube Short-Wave Set

ALL BANDS up to and including the aircraft beam signals can be worked with this one-tube receiver. The tube is a twin-pentode 1E7G, operating as a push-pull detector. Its output is sufficient to permit operation of a magnetic speaker on the broadcast band when close to the transmitter. Two 1.5-volt dry cells supply the "A" current. The tube operates satisfactorily with 45 volts on plates and screens, but best results are obtained with 90 on plates and 45 on screens. Two plug-in coils are used on each band, tuned by two .00014-mfd. variable condensers. Any type of antenna will do, though with one longer than 20 feet a trimmer condenser may have to be used in the antenna lead for short waves.



Above, top view; below, bottom view, and left, hook-up of the one-tube push-pull short-wave receiver. Two 1.5-volt dry cells supply the "A" current; "B" current runs 45 to 90 volts. Any type of antenna, ten to 75 feet, will do

Valentine photographs Jane Frazee, of Universal Pictures, with his 16-mm. movie camera. Illumination: two photoflood lamps near camera and a baby spot

Too many lights "wash out" the subject's features for close-up photography. Note the blanched look on Miss Frazee's face

Movie Lighting to Rival Nature

By JOE VALENTINE

As one of Hollywood's top-flight directors of photography, Joe Valentine has seen 100 film plays unfold before his cameras. These include all of Deanna Durbin's pictures. Both on location and at home he experiments constantly with his 16-mm. home movie camera to discover better ways of lighting his sets at Universal Studio. In the accompanying article he explains his methods in detail and tells how amateurs may improve their pictures by expert use of ordinary lighting equipment.

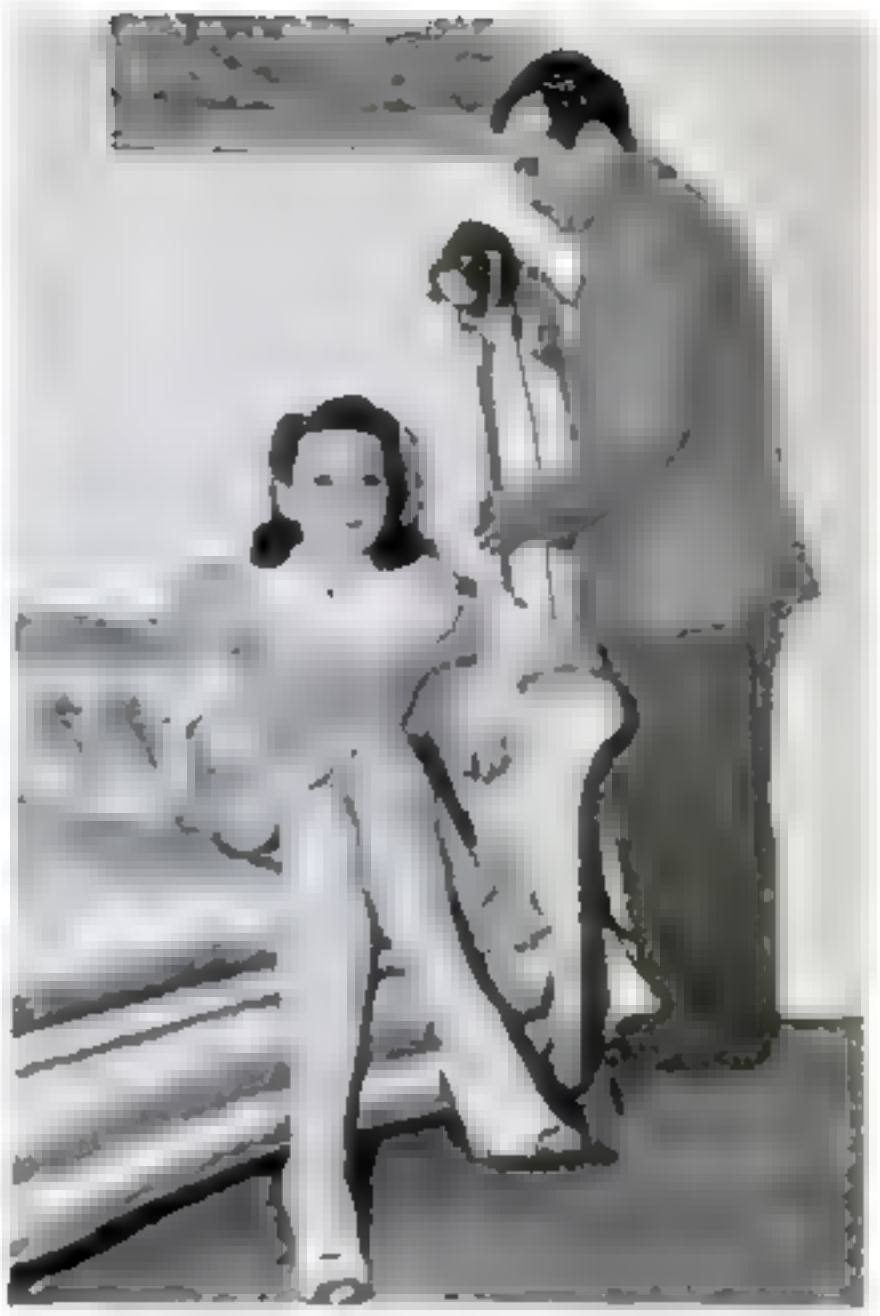
IF YOU are able to approach nature's perfection in lighting home movies, you have wrought a miracle. Lighting requires more than the mechanical steps of placing your illumination at various points and cranking the camera. Through practice your eye should become accustomed to "see" light. This may be achieved by seizing every occasion to study the appearance of faces, as well as inanimate objects, under varied lighting conditions.

When outdoors, note the position of the sun and how faces change appearance as the sun climbs toward the zenith. Similarly, when you observe interesting lighting indoors upon a face or object, always look for the source or sources; then study the reflecting surfaces.

These accidental observations must not be considered as hit-or-miss arrangements, because they are the real lighting of nature. Your objective in photography by artificial light should, therefore, be to imitate and not falsify them. Unless you seek trick or so-called "effect" lighting, you can do no better than hold the mirror to nature.

For best results, it is a good plan to make tests before proceeding to shoot several hundred feet of film. Hollywood directors of photography make exhaustive tests and shoot close-up after close-up of the stars before the picture starts. We shift our lights until we know exactly the effects you'll see on the screen.

True, we have unlimited numbers of lights of all kinds available for our pictures, complete with scrims and "goboes" and diffusion materials. But don't let our vast equipment dismay you, for you require only a fraction as much. You can get along for close-ups with two floods and one spot, though I recommend six floods and two spots. These will cover nearly any indoor scene you may wish to photograph. Cost will total less than $25, especially if you buy clamp-type floods instead of collapsible standards.



Placing the 100-watt spot to act as a back light over Miss Frazee's head and illuminate her hair

Let's suppose you are ready to film a sequence showing a pretty girl sitting on the davenport. What, you ask, is the secret of lighting her properly? Very simple. Place the lights so as to get balance, contrast, and roundness.

These three elements are essential to the production of pleasing pic-

In spite of 20 years' professional experience, Valentine isn't content to set up his lights and let it go at that. He tries out various effects by moving the key light from side to side around the face

When a subject is posed before a window, it is necessary to take a meter reading of the illumination on the face and another reading into the window. The former should be one-fourth greater

tures, and may be easily achieved by placing two source lights near the camera and a back light over the subject. Remember to elevate all lights about 18" above the level of her head to avoid a washed-out appearance.

If you have no baby spot available, flood lamps will produce excellent back lighting, provided only they are so placed that their rays do not strike the camera lens. The function of back lighting, of course, is to get a visual separation between the person and the background and produce high lights on the head and shoulders. Unless this light is placed behind the subject, undesirable hair shadows may be cast down the forehead, or the nose may cast a shadow across the face.

Double source lights should be avoided, because this type of lighting flattens the face and produces double shadows. It is much better procedure to use a single-source key light, with a back light high-lighting the hair. When using photofloods at home, I place a pair of them alongside the camera about six feet from the subject, with the back light, in the form of a 100-watt spot, about 18" above and back of the head.

For a full-length of your subject, when you need all the illumination possible, lights alone will provide the roundness and soft shadows necessary for proper modeling. When you move in for a close-up, the flat illumination and sharp shadows rob your subject of her beauty—or masculinity in the case of a man. Then you will need some diffusion to spread the light and yield better shadow effects.

Any of several materials fitted tightly over the source lights will serve the purpose, depending upon the effect you desire. Small squares of silk, either white or black; or tulle, veiling, or netting, with meshes of varying diameters. Not long ago while taking a close-up scene of Deanna Durbin singing beside a piano, I tried several nets. One by one, these were scorched by the hot lamps, with the result that the yellow light

Portrait Lighting—Good and Bad

RESULTS of proper and improper lighting are shown in the accompanying four portraits of Jane Frazee, Universal Pictures featured player. 1. The key light is too high. Ugly shadow under the nose. Laugh lines accentuated, eyes too dark, no high lights in the hair. 2. Source light too far to the left side. Ugly shadow on forehead. Nose flattened and spreading. Chin disappears into neck. Bad shadows and circles under eyes. 3. Still definitely bad. More flat light, with the key light striking from the side. Too much fill light, resulting in a flattening of the face. 4. At last the young player's beauty asserts itself. Key light strikes from a point near the lens, with a back light illuminating her hair. Ugly shadows and lines have gone.

changed to brown and "dirtied" her face. Suddenly I hit upon the idea of trying ordinary black-wire window screening. Through it I was able to spread the light, yet retain the desirable shadows.

While your primary photographic interest centers in people, experience will teach you that lighting effects may also be created to heighten dramatic qualities.

Your script, for example, may call for the heroine of your home drama to descend the stairs. You set up your lights and note she's moving along a blank wall, which gives a monotonous background for otherwise interesting action. Simply place a small spot near the floor so as to cast shadows from the railing against that wall.

You have seen excellent sun effects on the screen, of people moving among the lights and shadows of a curtained window. In Hollywood, we never rely upon the vagaries of the sun for effects when shooting indoors. The formula to follow is simple: Cut a piece of cardboard 16" by 20" in the shape of a window, drape two lengths of cheesecloth to resemble curtains, and place the make-believe window in front of a source light. By varying the distance between light and "window," you can cast a shadow of any desired size.

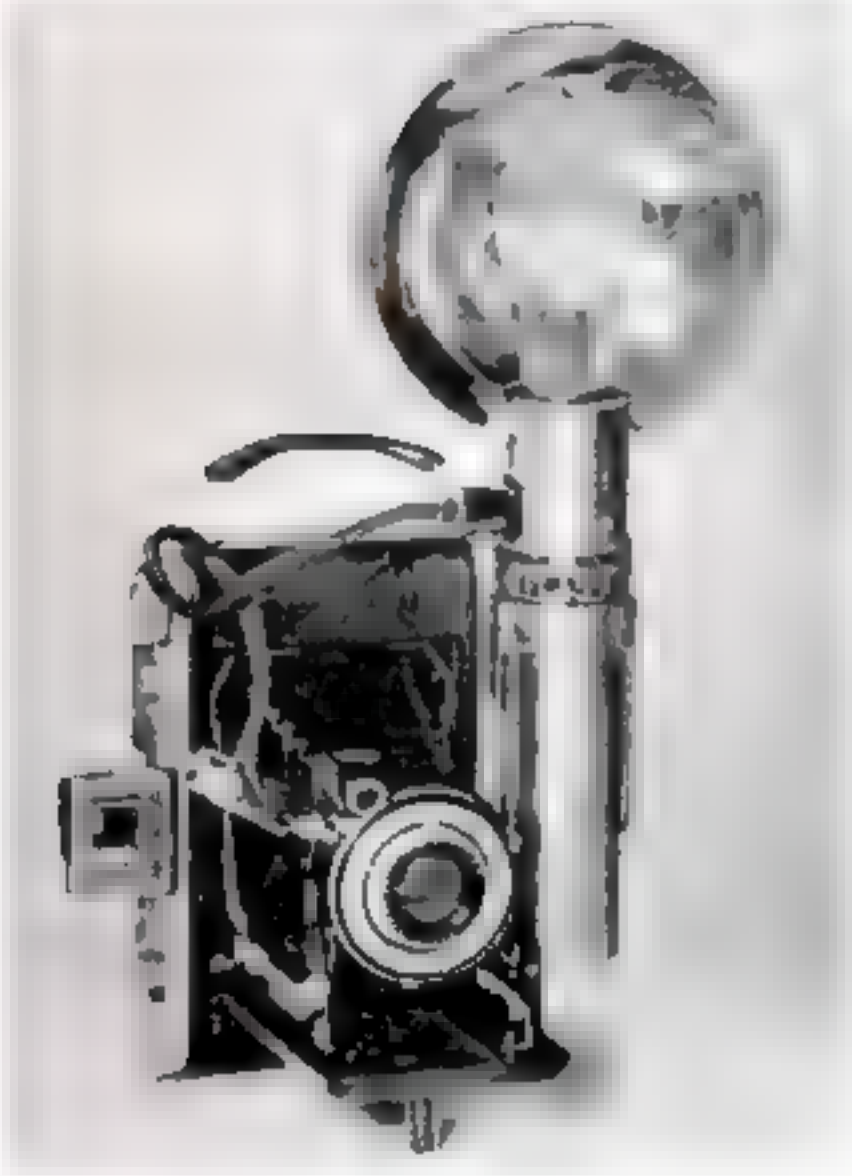
Both in natural and artificial light, most amateurs generally overexpose their negatives. Therefore, until your eye is able to evaluate light, I advise the use of an exposure meter. For extreme close-ups, except when shooting toward a window or other natural light source, take the reading directly on the face, holding the meter perhaps 12" from the nose, but make sure no shadow is cast by your hand to change the light value. On a full figure, the entire field must be covered, readings being made on the figure and the background on both sides. Take an average of the readings.

For softening the light, many diffusing materials may be used. Here Valentine is experimenting with a small bit of cellulose gloss substitute

Suppose, now, you plan a sequence showing your subject against a window sitting in a chair or playing the piano. You will want the outside illumination, yet, except for a silhouette, desire her face to show up brilliantly. Place the lights as usual, the source beside the camera and a back light over her hair. Take a reading directly into the window, another on her face. Move the light in until the face reading is one-fourth greater than the window reading, as 125 foot candles and 100 foot candles. This ratio will give the necessary balance and provide an effective picture.

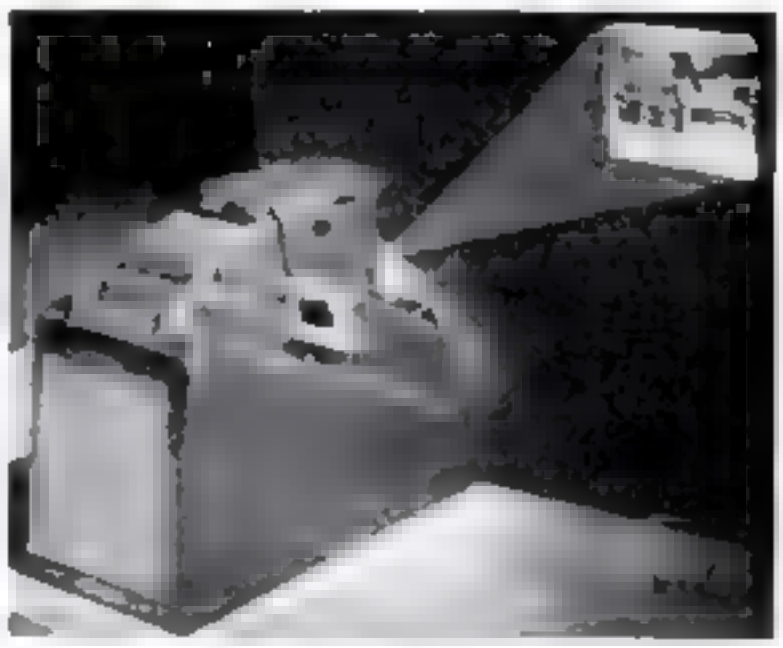
FOR CAMERA USERS

DATING KIT. Prints may be dated permanently with a new kit designed for use with any ordinary printer or printing frame. It consists of an overall border mask for negatives and a set of small tabs carrying dates. The date slips are inserted into slots in the large mask and changed as required.



FLASH GUN FOR AMATEUR CAMERAS. Operating on the solenoid principle, the magnetic synchronizer shown at the left is intended for amateur photographers and professionals who are using amateur equipment. It is adaptable to all shutter speeds up to and including 1/500 second, and may be used with multiple lighting systems. The design is suited to cameras with Compur, Compound, Kodamatic, Supermatic, Ilex Acme, and Prontor II shutters. Special fittings may be obtained to adapt the synchronizer to cameras having other shutters than these.

COMBINATION PROJECTOR AND VIEWER. By an ingenious tilting arrangement, the projector illustrated below can be instantly changed to an image viewer. The film, projected on a ground glass 7″ by 7″, can be seen in broad daylight. The case is heat-resistant plastic. Mounted Kodachromes, glass slides, and dental X-rays may also be projected.



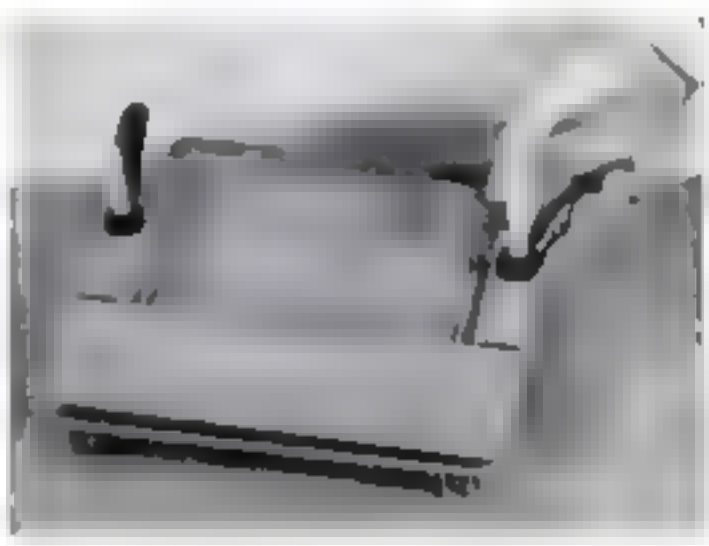
POPULAR SCIENCE

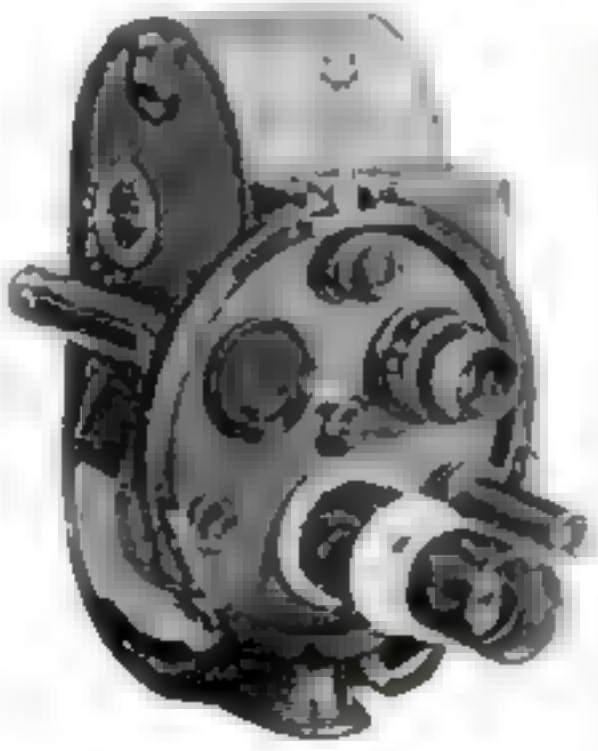
LAMP-TO-SUBJECT DISTANCES for indoor photographs are easily measured with a cord which has cards or tags fastened at distances of 4′ and 7′ from one end. Each card bears printed exposure data for guidance in taking pictures under artificial light.

PEAR-SHAPED LAMPS, from the No. 4 photoflood to the PS-52, 2,000-watt movie flood, can be focused to center the filament in the reflector of the lighting unit above. A positive-acting clutch yoke connects the housing through a swiveling device to the stand, thus affording a 360-deg. field of focusing. The stand collapses to 18".

A REVERSAL PANCHROMATIC FILM for 35-mm. miniature cameras is now available for amateurs who own small slide projectors. It is used like regular black-and-white films, but yields positive transparencies instead of negatives.

FOR FLATTENING PRINTS, a sturdy, durable, and convenient all-metal press is now being manufactured. Its heavy plates are reenforced with channel irons. Enamel is used on the plates and handles to prevent rusting, while the screws are cadmium plated. Rubber tips keep the supports from scratching table tops, and springs hold the plattens apart when not under pressure to permit easy insertion or withdrawal of prints. A durable baked-on gray wrinkle finish is used.





ZOOM ATTACHMENT. Many professional Hollywood trick shots can be approximated by the home movie maker with a new quick-shift zoom attachment, designed for the Filmo Turret 8. It makes possible an instant shift from one lens to another. So-called "wipe-ons" and "wipe-offs" may also be effected. Moving the lens out of position at the end of a scene causes a wipe-off, while returning the lens to the original photographic position creates a wipe-on. Other bizarre and picturesque shots are possible.

PROPS IMPROVE YOUR PHOTOS

PROPS are an important aid to every photographer who seeks better results than he can get merely by "pointing and shooting." Used with a little ingenuity and a judicious choice of camera angles, they can add pictorial interest and drama to otherwise ordinary subjects.

Here are a few suggestions by an expert in the use of props—Eyre Powell, of Los Angeles, Calif., who has been director of the Powell Press Service for 15 years. Thousands of his pictures have been published as evidence of his photographic skill.

1. Note the question mark of chrysanthemums in the accompanying picture. This pointed up the query as to which of these 12 girls, selected from 3,000, would be crowned queen of Pasadena's Tournament of Roses.

The numerals "41" might be similarly used to make an attractive graduation picture. To stage this, string white flowers into two chains, one about 40' long, the other about 13' long. Arrange them on a lawn as block numerals, bringing the ends near the camera close together, and spreading the far ends slightly to form a narrow "V." Place the subjects inside the numerals, and have them hold the chains up at the rear so they slope down toward the camera's position. This helps "square up" the picture. Shoot downward at an angle of 45 deg. from the top of a 15' ladder. Be sure to stop down to f/16 or smaller, increasing the exposure time accordingly, to obtain depth of focus and sharp detail.

2. Objects of unusual size, such as tall

The figure stands on a support concealed by the cornstalks. Exposure, 1/135 second at f/11; film, Super Panchro Press. The shot at the right was made on a dull day. Film, Panchro Press; exposure, 1/75 second at f/16

Shooting upward streamlines the subject's figure. Taken without a filter; stop, f 16; time, 1/135 second

corn, prize-winning hogs, or toy dogs, should be shown in contrast to human beings. Each enhances interest in the other. If it's corn, for example, bind about 18 stalks together and support them in an invisible manner, either by means of a ladder or a "two by four" sunk into the ground and fitted with horizontal crosspieces. Let some one climb up and peer down from the top. Shoot the picture from near the ground, preferably across the sun.

3. For vacation or outing pictures, the prop may be merely an old stump or a rock, upon which your subject stands. Again shoot upward, from a position about two feet below the subject's feet. Note in the accompanying picture of a girl on a wooden pile how two cameramen are shooting from eye level, a position which here affords the desired angle.

4. In most households can be found a large discarded picture frame. By placing

This subject was "framed," but with pleasing results. Tilt the frame forward to avoid distortion when shooting from below. Clever variations are possible. Made with a 4" by 5" Graflex on Panchro Press Film. The exposure was 1/135 second at f/16

the subject so that his head appears within the frame, you can photograph a "living portrait." If the frame is large enough, a full-length portrait may be taken. Use gold frames for blondes, dark frames for brunettes. Remember to tilt the frame slightly toward the camera to avoid distortion and foreshortening of the top.

For an interesting variation on this, have two persons face each other through a single frame. Place the camera slightly to one side of a line connecting the subjects, and focus for the frame. Arrange your subjects so that one appears to be a reflection of the other.

5. When photographing youngsters, it's best to give them something to do. Have them playing around a miniature house, for example. Place the camera near the ground and shoot at a slight angle upward, thus dodging out the background. To avoid set expressions, let them play naturally.

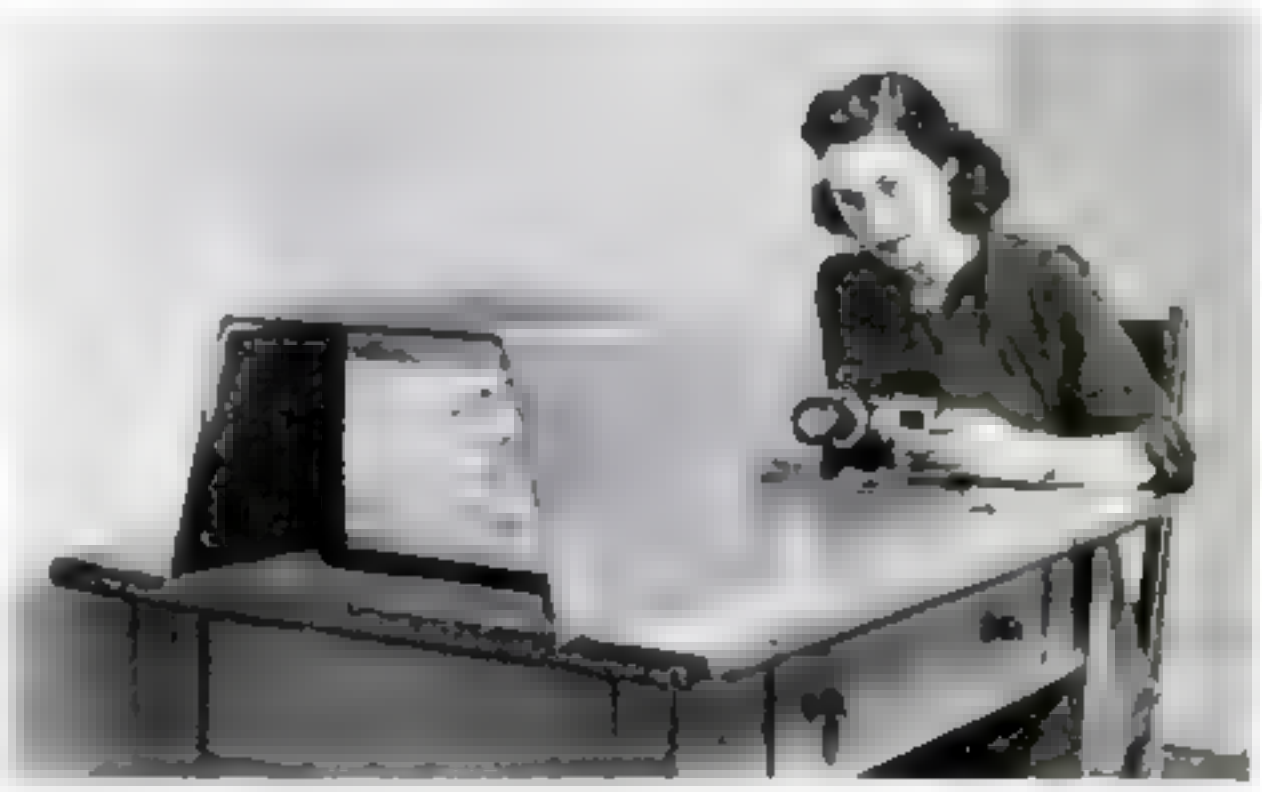
For best results, Powell says, pictures should be thought out carefully in advance of the actual shooting. Emphasize the central theme by avoiding "fussy" backgrounds, and "tone up" sky shots by using the K-2 filter. Finally, use fast film on such "deep" subjects as the flower numerals so you can shoot at moderate speed to arrest action, yet stop down enough to gain depth of focus.

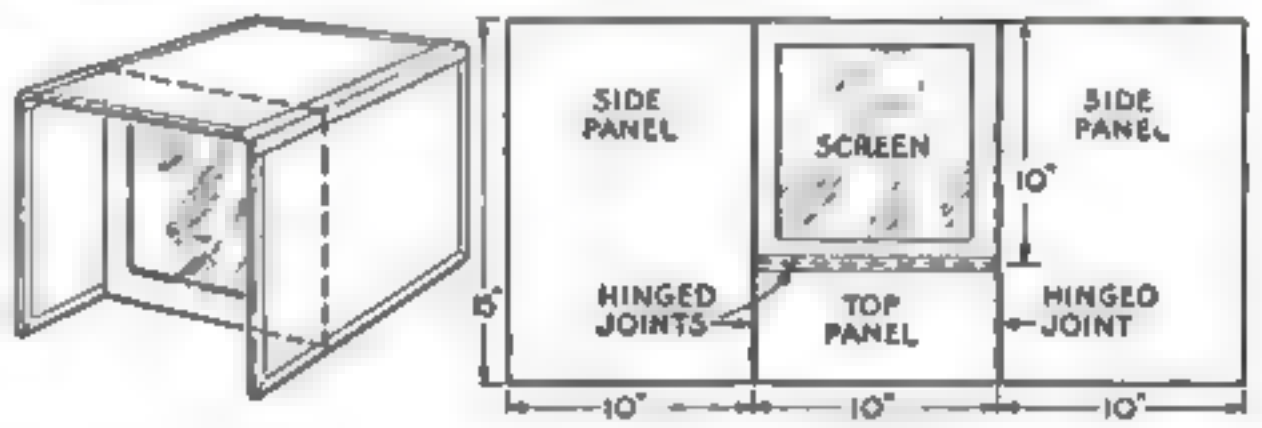
Children at play provide action aplenty. The low camera angle eliminates unwanted background

Portable Daylight Screen for Color Slides

THIS folding daylight screen for showing color slides by rear projection can be quickly made of easily obtainable materials. In a cardboard mat 10" square cut an opening 8½" square, over which tape a piece of thin tracing paper the same size as the mat. Bind with tape carried well over the edges.

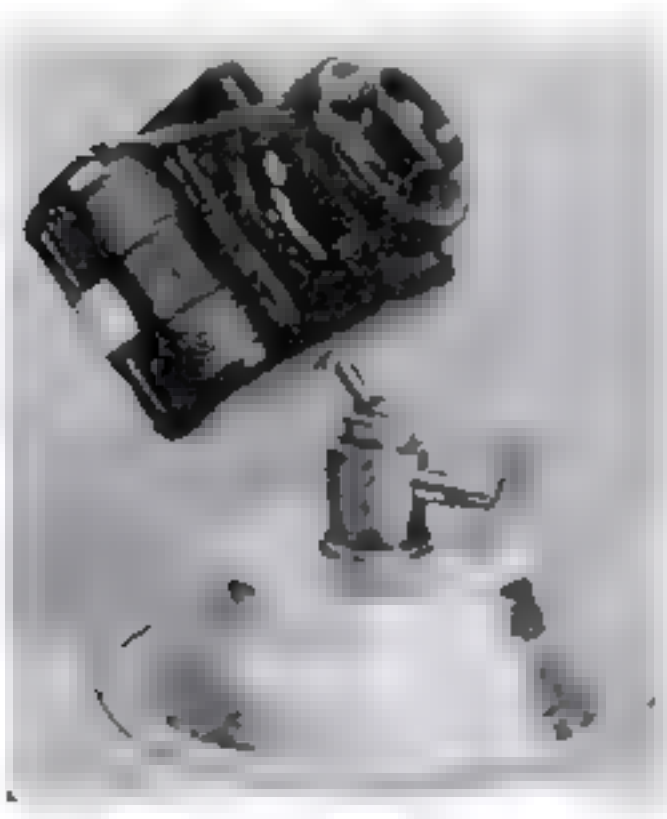
The hood consists of three rectangles of black cardboard, each 10" by 15". Bind all edges with tape, and with crêpe-type adhesive paper tape fasten these three panels together by the long edges as shown, leaving a gap of ⅛" or more between the pieces so that the hinge action will have free play. With tape fasten one edge of the screen to the center panel of the hood so that, when folded flat, the bottom of the screen lies flush with the end of the panel. Before finally taping the parts together, it is advisable to stand them up in their desired positions in order to check the hinge clearances. Allowance must also be made on the screen panel for the thickness of the tape hinge itself to assure proper assembly.





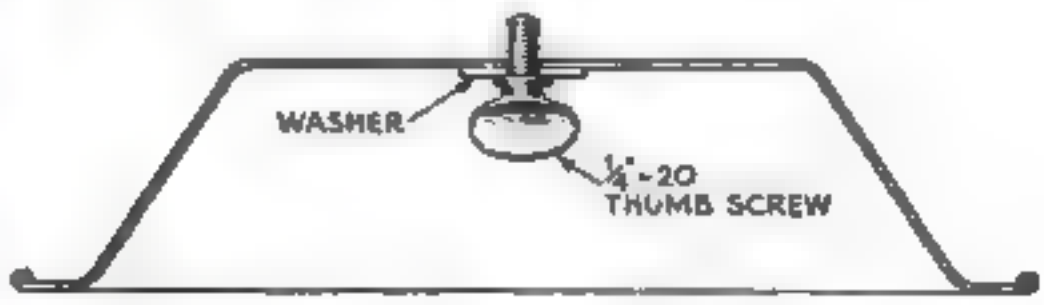
Made of low-priced materials, this screen folds for carrying in a brief case. Slides throw brilliant images on it even in a normally lighted room

Dimensions given may be proportionately increased if desired, but a smaller screen would not be practical for use with most commercial projectors. Slides must be inserted in reverse position in order that they will appear correctly when viewed by rear projection.—ROY L. PEPPERBURG.



Tin Pan Used as Table-Top Tripod to Support a Small Camera

A THUMBSCREW and a tilting head will convert a small pudding pan into a camera support for use on a table or for taking angle shots from the floor. The single hole required can be punched with an ice pick or even a nail. A washer should be used under the screw.—ARTHUR TRAUFFER.



This winter scene was taken on Kodachrome by using a pinhole instead of a lens. It has been reproduced by a two-color process, but little has been lost except a slight tint of red in the distant chimneys at right

Color Shot
TAKEN WITH
Pinhole Camera

A PINHOLE was used instead of a lens for taking the photographs from which the accompanying illustrations were made. One is a two-color reproduction of a winter scene taken on daylight Kodachrome with an exposure of two minutes. The distance from pinhole to film was 5".

The illustration at the right is interesting because the dark borders, top and bottom, are the bellows and lens flange of the camera. The bed of the camera, projecting into the foreground from the bottom, is in just as sharp focus as the Pony Express statue in the middle distance and the building in the background. This was taken on Panatomic X film at 2" with an exposure of four seconds.

Black paper like that used in packing films may be used for a pinhole diaphragm. A fine sewing needle (No. 12) is held perpendicularly to the paper and rotated slightly until the point is through. The burr is then removed with a new razor blade. The Kodachrome was taken with a hole of this type. Thin brass also may be used, but for best results the metal should be chemically blackened. The Pony Express picture was taken with such a pinhole.

I mounted the pinhole in a broken down old plate camera, and used pins to sight along in order to determine the edges of the picture because there is not enough light to see an image on the ground glass. I have also used an Eastman pinhole camera, which I changed into a wide-angle camera by curving the film one way around a semicircular block. The focus, of course, stays sharp.—WESLEY TILDEN.

Everything is in focus in this view, from the bed of the camera in the lower foreground to the building in the background

PHOTOGRAPHY'S GREATEST THRILL... COLOR with a MINIATURE CAMERA

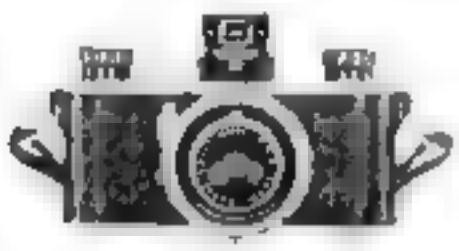
On your own home screen—gorgeous full-color "stills"—with KODACHROME—at surprisingly low cost...

COLOR "STILLS"—brilliantly gay and breathtakingly beautiful—are today's No. 1 thrill among miniature-camera owners.

With a Kodak Bantam *f*/4.5 or a 35-mm. camera such as the Kodak 35, anyone can make these full-color "stills" with Kodachrome Film. They're enormously popular. As easy to make as black-and-white. And you'll be surprised to learn how little they cost. With Kodachrome, the initial cost is the whole cost—your finished transparencies, in slides which are all ready to project on your own home screen, are paid for when you buy your film.

Your dealer will be glad to show you cameras loading with this wonderful full-color film, and to project a variety of sample "stills" for you with a Kodaslide Projector . . . Eastman Kodak Company, Rochester, N. Y.

These Kodaks make full-color KODACHROME "stills" as well as pictures in black-and-white

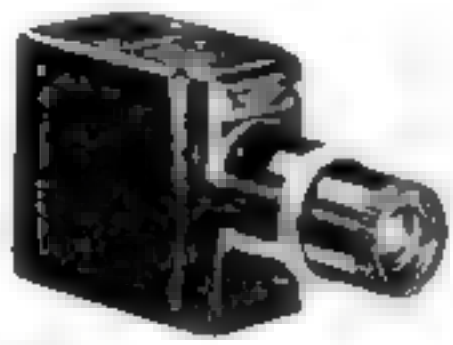


$14.50 Kodak 35 f/5.6
(Shown above)

Compact, smart, convenient-to-carry. Precision construction. Kodak 35 *f* 4.5—$24.50. Kodak 35 *f* 3.5—$33.50; with Coupled Range Finder, $47.50.

$22.50 Kodak Bantam f/4.5
(Shown below)

So small it fits the palm of your hand; fast, versatile, easy-to-operate. A precision miniature.



For Projection . . .

Kodaslide Projector Model 1—small, efficient, thoroughly dependable. Complete with lens, lamp, and 11½-ft. cord—$18.50.

Gus Rescues an Amateur

(Continued from page 144)

He did another job of thinking, and then got out and connected a neon-pencil tester and asked the driver to start the engine. He held the pencil on the Number One plug and watched the spark. For a while it came through heavy and even. Then it cut out suddenly. The engine lost its momentum and stopped.

Gus cussed. Then he reopened the distributor, and went over its head very carefully for a dirty contact or a crack that he might have missed on the first checking. He couldn't find anything. Next he took off the rotor, and just as carefully checked it for a loose or dirty contact between the contact spring and the brass brush. But the rotor seemed to be in as perfect condition as the distributor head. He cussed some more, put the rotor down on the still-warm manifold, and went on checking.

Finding nothing wrong anywhere, he began to replace the various parts. When he picked up the rotor he noticed that it was warm. Looking at it closely, he saw that a tiny hairlike crack had appeared across about three quarters of the width of the contact spring.

Gus held the rotor away from the engine, and as it cooled watched the crack disappear. He put the rotor back on the manifold, left it there for a minute, picked it up again, and saw that the crack showed.

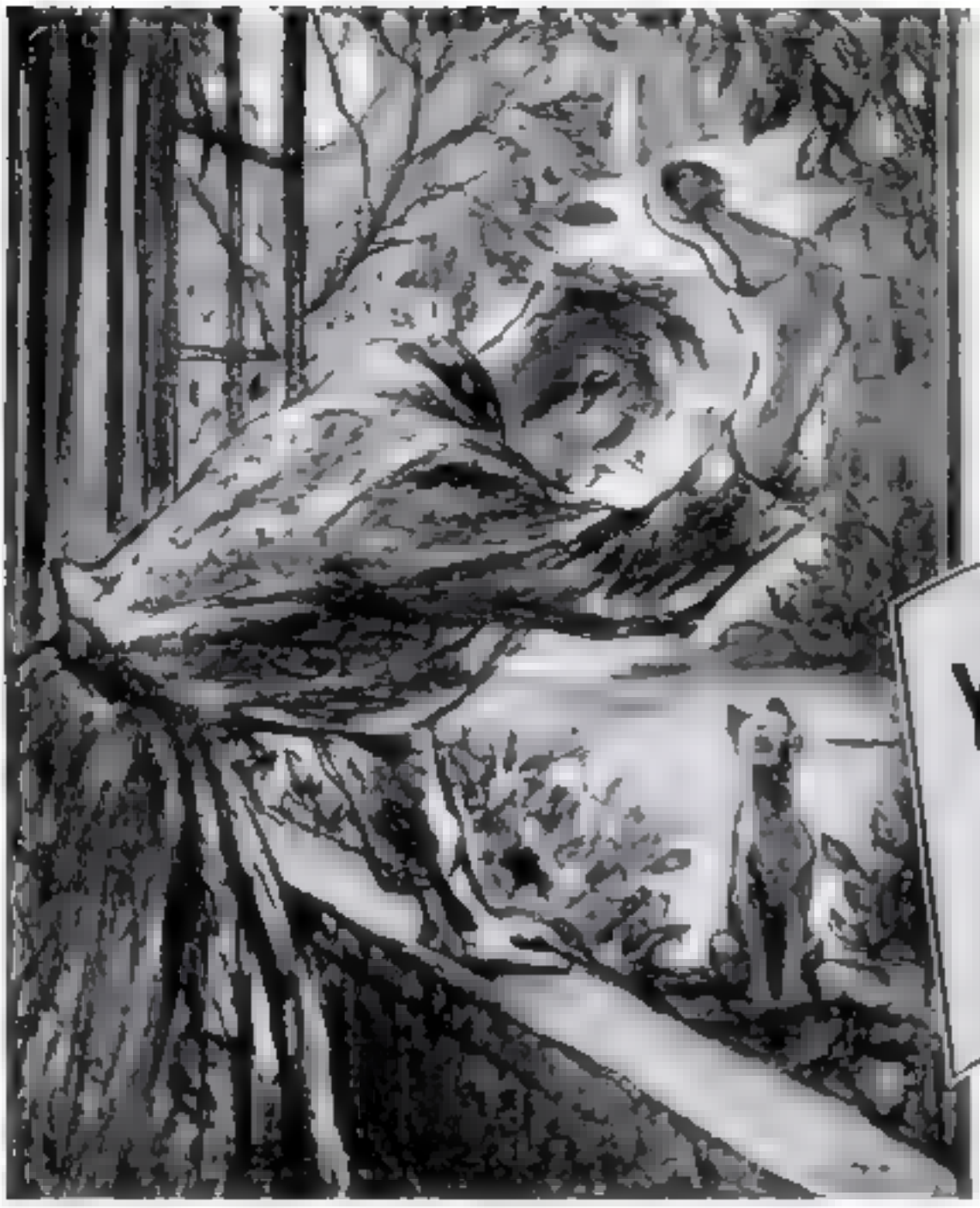
"You'll be able to make your delivery tonight, all right, so the country's saved," he told the driver. "Your engine will run as good as new as soon as I put on a new rotor—and that won't take a minute."

"That's swell!" the driver said. He picked up the rotor and stared at it. "But I don't see anything the matter with this-here gadget."

"That's what fooled me," Gus said. "There's a crack in the spring, but it closes up as soon as the metal cools. That's why your engine runs fine for a minute or so before it stops. When the current flows through the spring it gradually heats it enough to make the crack widen out and leave so little unbroken metal that it can't carry enough current to jump the gaps at the spark plugs. Get it?"

"No, I don't," the truckman admitted frankly. "And I'm blamed if I can see how a crack so little that most of the time you can't see it can lay out a whole truck."

Gus laughed as he started to put on the new rotor. "That's the way it is in this business," he said. "A lot of the big troubles come from mighty small causes!"



You may worry about the love-sick cat

but here is one worry you can avoid

You can silence the cat with a well-aimed slipper but that's small consolation if he's back tomorrow night.

The same is true with your car. You can silence chassis rattles with ordinary grease, but not for long.

What's needed is Marfak. Because it is made of highly refined, heavy-bodied oils scientifically blended, Marfak is a longer lasting, tougher, more tenacious lubricant. It sticks to its job long after ordinary grease has been jolted off or washed out.

Drive in where you see the red and white sign: "Let Us Marfak Your Car," and get Texaco's famous 40-Point Chassis Lubrication Service by a trained expert who works by chart and not by chance.

Your car will ride like a new one, easier, quieter and you can forget about chassis lubrication for 1000 miles.

TUNE IN FRED ALLEN

Texaco Dealers invite you to enjoy Fred Allen in the full-hour program of the TEXACO STAR THEATRE . . . with Kenny Baker, Al Goodman's Orchestra and a great cast. Every Wednesday Night. Columbia Network. 9:00 E.D.T., 8:00 E.S.T., 8:00 C.D.T., 7:00 C.S.T., 9:00 M.S.T., 8:00 P.S.T.

TEXACO'S 40-POINT CHASSIS LUBRICATION SERVICE AT ALL TEXACO AND OTHER GOOD DEALERS

Dogfighting

(Continued from page 118)

planes, as well as a distinctive insignia painted on the planes.

All the while he is perfecting himself in dogfighting and gunnery, the young pilot must also be developing as a formation flyer. He is now able to fly in complicated tactical maneuvers with his whole squadron.

There is one maneuver which the pursuit flyers perform to impress foreign dignitaries, and it demonstrates as well as anything the skill that these squadrons attain. "Sandwich fire," as this maneuver is called, is the concentration of all a squadron's guns on a single ground target.

The 18 planes are flying in three flights of six, each in flight front, one above another. The squadron commander is at the left of the top flight. The two flights below trail a little behind, like steps.

Now the squadron commander tilts his formation into a dive toward a three-foot bull's-eye, far below. The steps straighten out into a solid curtain of gun muzzles speeding toward the target. As the planes dive, they are all converging toward a single point, drawing closer together.

At 2,000 feet they open fire, with all machine guns blazing away. At 1,000 feet, still firing, every one still holding true to the bull's-eye, their wing tips are nearly touching; the planes of Flight B, the "meat" of the sandwich, have planes scarcely more than two feet above them and two feet below. The pilot in Flight B cannot see the plane below him, can judge its position only by the planes on either side. In a split second more, all converging toward a single point, they would come together in a tangled mass of wreckage.

At this instant the flight commander swoops his plane upward, in a left turn; and simultaneously his flight makes a similar turn, swinging into string formation. Immediately behind them, but at a lower level, Flight B makes the same upward turn, clearing the way for Flight C to pull out of its dive. In less time than it takes to breathe, they are flying off to the left in normal string formation—echeloned right just enough to keep out of each other's prop streams.

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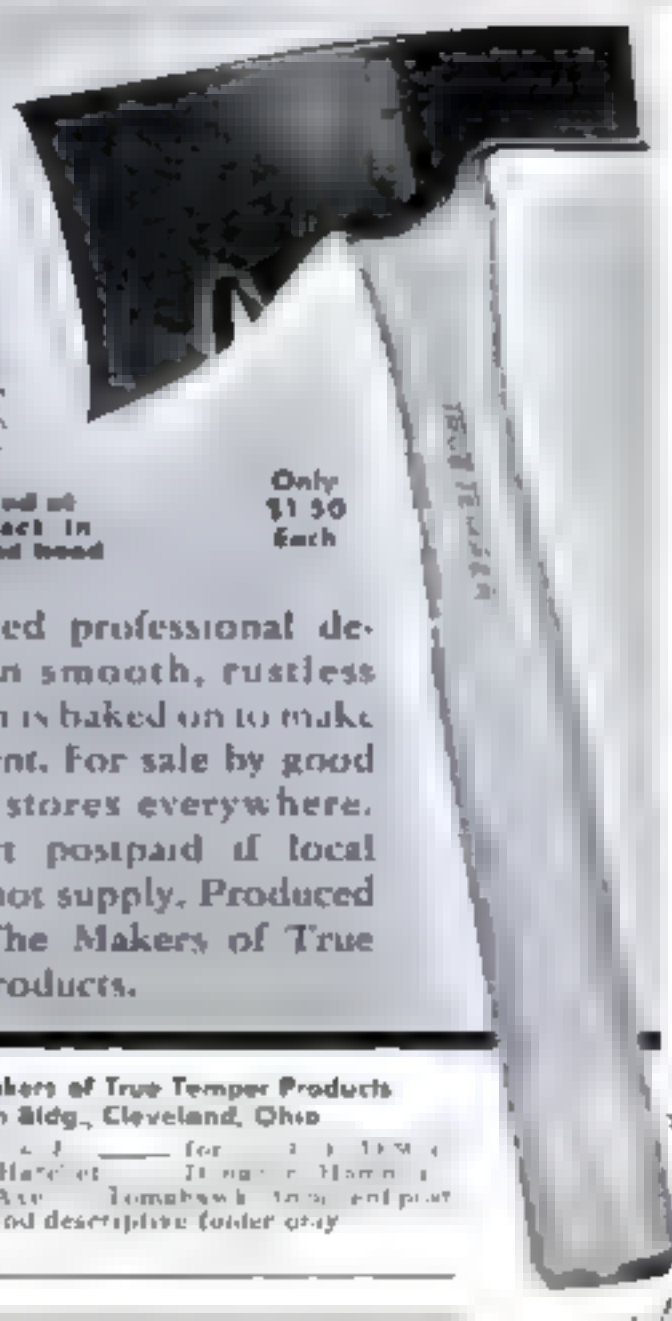

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Vent allows air to escape when grease is forced in

When gun is full, a small bolt is screwed in place

Question Bee Answers

HERE are the correct answers to the "What Is It?" quiz appearing on pages 120 and 121.

1. Cyclotron
2. Cirrus
3. Air
4. Expansive bit
5. Miter box
6. Monarch
7. Aircraft carrier
8. Lathe face plates
9. The moon
10. Dovetail joints
11. Diatoms

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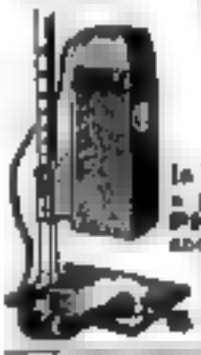

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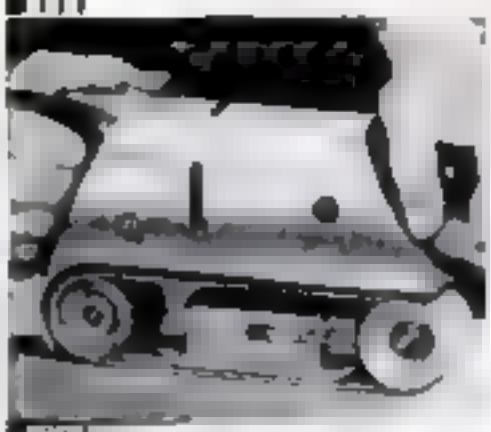

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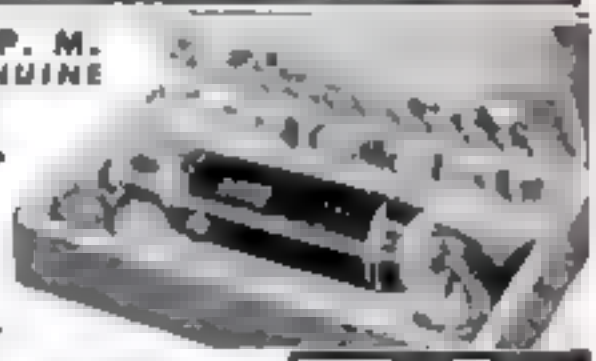

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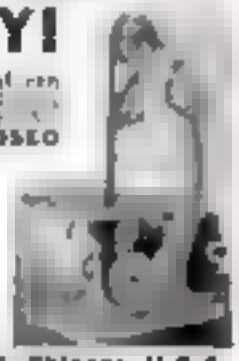

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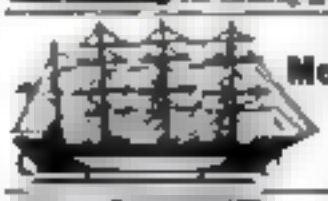

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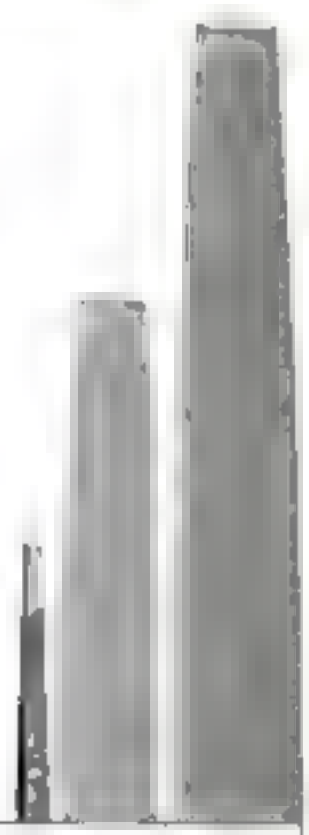

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(Continued on page 227)

Plans for Tested Projects

(Continued from page 226)

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Charge of the Iron Brigade

(Continued from page 125)

that in the so-called boom year of 1929, the American machine-tool industry had produced approximately $185,000,000 worth of machine tools. This dollar volume represented the peak production since 1918, and therefore could be considered close to the maximum capacity of the industry.

Almost immediately following this boom year, our machine-tool orders fell off rapidly, until for the years 1932 and 1933 our machine-tool production dropped to an average of $23,500,000—less than one seventh of the 1929 peak. This low volume did not change materially during 1934, when Germany began a high-pressure expansion program of her own machine-tool factories. That year Germany doubled her machine-tool production, and continued her policy of doubling it from then on to 1939, when the United States, recovering from the depression, found an export market for $100,000,000 worth of machine tools. Most of these were purchased by countries beginning a belated and feverish race to reëquip their arsenals and munitions plants.

There are no reliable figures on Germany's machine-tool production for the year 1940. The American figures for the year just past, both export and domestic production, are a little more than double those for 1939—that is, American machine-tool production for 1940 reached $450,000,000. It is a reasonable assumption that Germany's production did not increase in like proportion. And it is not guessing at all to say that the German high command was seriously perturbed by this unexpected doubling of American output.

It is no longer a military secret how the American machine-tool industry stole a march on the German high command. In the first place, the American machine-tool industry—of which some 115 companies represent 80 percent of the total capacity of the country—is composed of comparatively small factories closely bound together by common interests and a common pride in their basic importance to all other American industries. If a manufacturer of shoes wishes to erect a new factory, he goes to the shoe-machinery builders for his equipment. But the shoe-machinery manufacturer must in turn go to the machine-tool industry for the necessary lathes and drill presses and other machine tools with which to make shoe machinery. Where does the machine-tool builder go for *his* machinery? Well, he either makes it in his own shop or calls on

(Continued on page 230)

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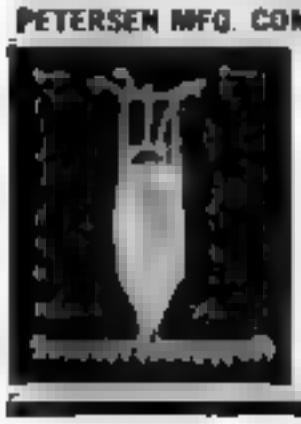

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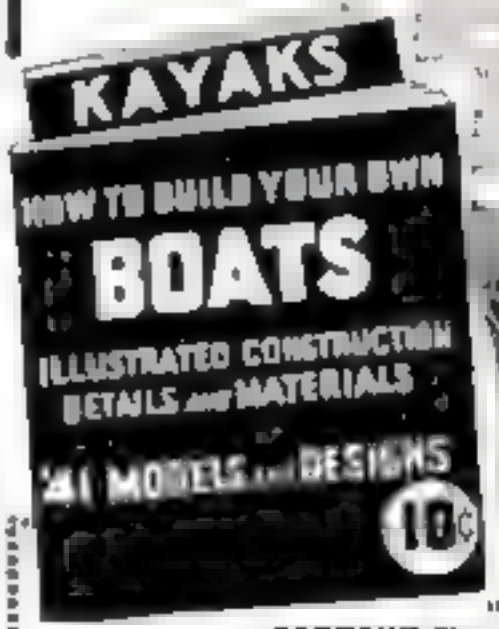

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Charge of the Iron Brigade

(Continued from page 228)

his brother machine-tool makers to supply it. But the dyed-in-the-wool machine-tool builder takes pride in the fact that, in a pinch, he can make any machine he requires.

The American machine-tool industry, as a consequence, has its finger on the pulse beat of industry the world over. Neither war production nor peacetime production can be planned anywhere about the shores of the seven seas without the American machine-tool industry being the first to learn of it. When war broke out in Europe in September 1939, the American machine-tool builders had long known it was inevitable. Knowing the wretched condition of the French machine-tool plants especially, they foresaw the grave danger menacing the democracies of the world.

Fully a year before the invasion of Poland, American machine-tool builders quietly checked into the available supply of skilled mechanics and foresaw the shortage we are now facing. Acting on this knowledge, machine-tool plants all over the country expanded their apprentice-training programs in anticipation of the demand for skilled mechanics capable of maintaining the high standards of precision and workmanship for which American machine tools have always been famous. The success and extent of this training program is reflected in the fact that approximately half of the mechanics working in American machine-tool plants today have been trained on the job since September 1939.

This foresight and initiative exhibited by the American machine-tool builders caught the German high command by surprise when it learned that American machine-tool production for 1940 would exceed $400,000,000 instead of the inconsequential $200,000,000 which German experts had predicted would be the maximum for at least another year—when the war would be over.

Now the German high command has received a new surprise. American machine-tool production of $450,000,000 in 1940 was no fluke. It is continuing to expand at an ever-increasing rate, and it is freely predicted that the volume for 1941 will reach $750,000,000, or even exceed it.

Germany knows full well that a successful general can make all the mistakes in the book but the last one and still win the war. It is possible that the German high command has made that "last mistake"—that of vastly underrating the productive strength of the Iron Brigade of the American machine-tool industry, now on the march!

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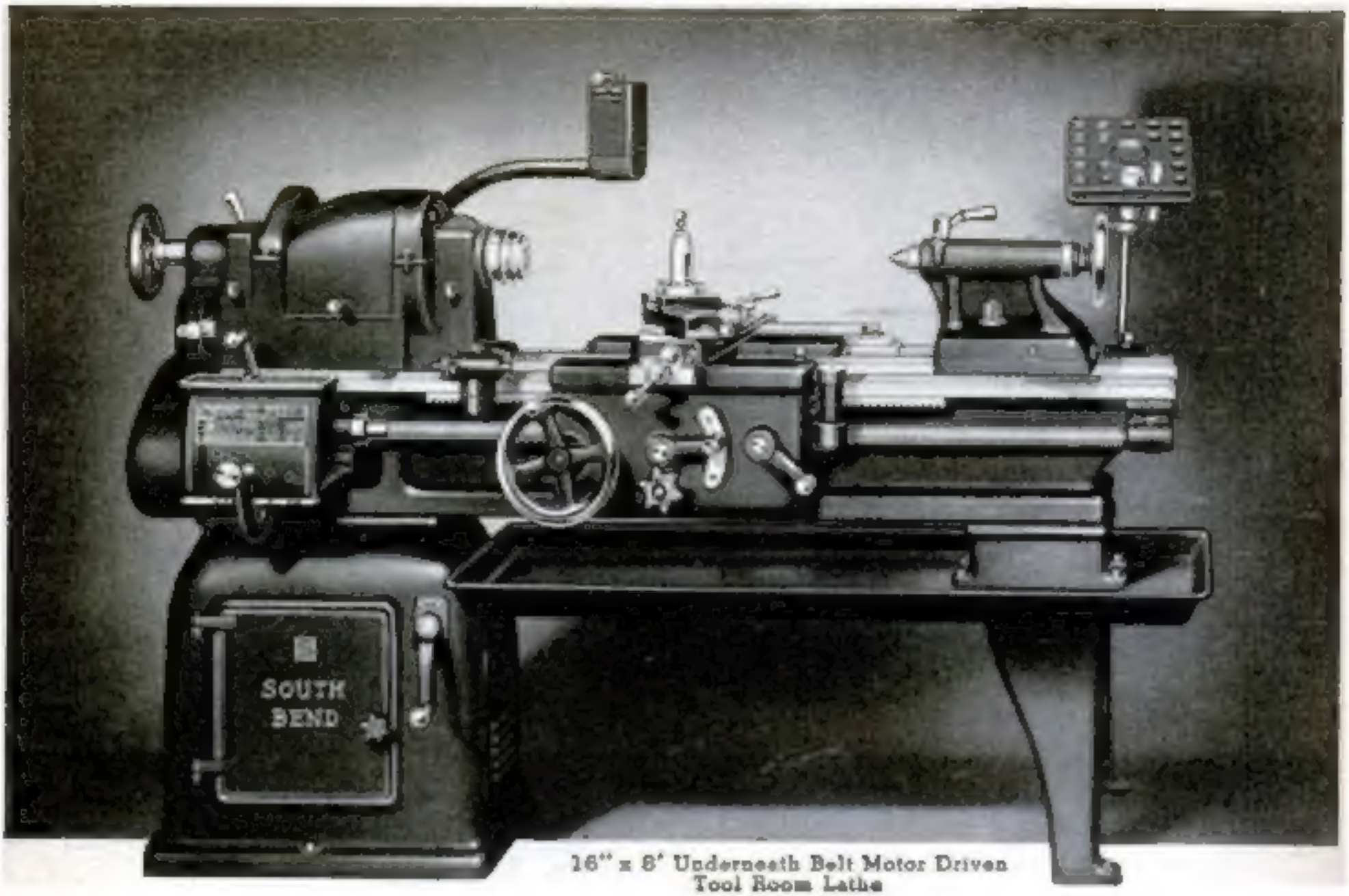

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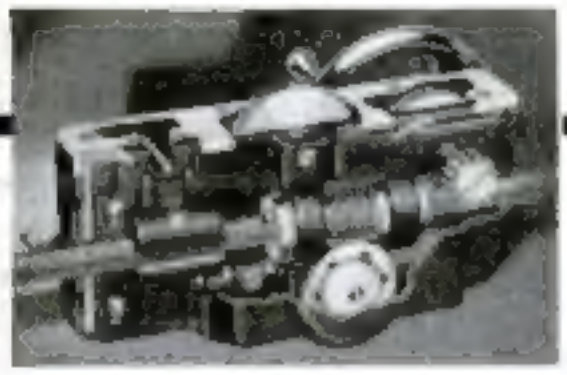

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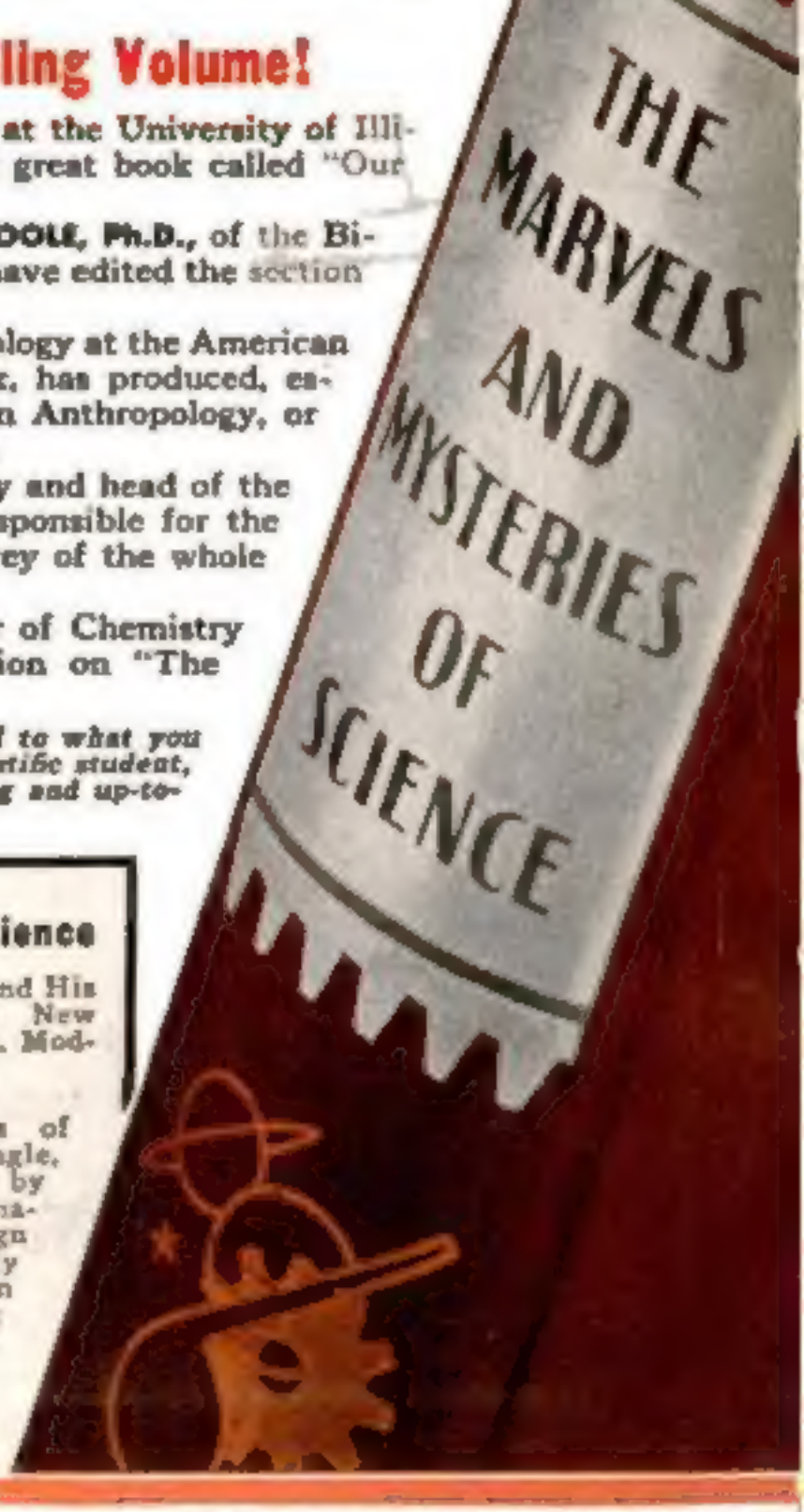

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